Corporveillance: Dancing with A.I.

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CORPOVEILLANCE

DANCING WITH A.I.

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Royal College of Art

This thesis represents partial submission for the degree of Doctor of Philosophy at the Royal College of Art. I confirm that the work presented here is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

For my parents, Dominique and Kevin, as testament to the value of their unwavering support. And for my grandmothers, Margaret Garnett and Jacqueline Guérin, who nearly saw those lofty letters appear after our family names. This work is thanks to them.

i. ABSTRACT

Often germinating in the Big Tech companies of Silicon Valley, technologies designed to generate human-like speech, text and digital imagery are advancing rapidly. It is not unimaginable that these advancements will spread to encompass human movement and affect societal freedoms or corporeal identities. In response, this research positions dance as a form of resistance to raise questions of human agency in the face of these increasing deployments of digital technologies and artificial intelligences. By using choreography as a mode of inquiry it employs the body to explore how humans may control consent, retaining ownership of their corporeal data, by asking:

- **What can dance choreography reveal about AI touching our bodies?**

This interdisciplinary, practice-based study sits at the intersection of human-centred computing, contemporary dance, and body-worn technology. The practice-as-research framework employed enabled a hybrid methodology to form, drawing from choreographic, constructivist, ethnographic and autoethnographic methods. A facilitated co-development process executed through a series of practical workshops with professional dance artists supported the development of a choreographic system designed to create new choreographic material and an adaptable, bespoke body-tech exoskeleton. Built using off-the-shelf electronics, the apparatus can remotely communicate sequences of vibration to affect choreographed and improvised movement, exploring new techniques and movement languages.
Digital technology developments were reviewed alongside key artistic works, revealing that choreographic tools capable of affecting this creative process through physical contact had not yet been devised for the purposes of investigating future AI impacts. This research argues that the individuality of improvised movements and the personal interpretations of the Graham (technique) contraction embody rebellion against encroaching data capture technologies such as human gait recognition, aimed at the surveillance and capture of human identities.

This research proposes new scholarship in the fields of dance choreography, digital technology, and artistic research in AI, contributing a novel choreographic method. By elevating the body as paramount within its architecture, its performance proposes a framework for integrating artificially intelligent algorithms and bodies, wherein human and AI actors possess agency in the creative decision-making process. The testing carried out during this research forms a journey of discovery and experimentation which aims to benefit industry- and academia-based creative practitioners and researchers who are experiencing the proliferation of AI.

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Completing a PhD requires efforts beyond its author. The work that has gone into the practice I have developed since the autumn of 2017, and that has coincided with this written thesis, came together thanks to some highly generous, supportive, and truly switched-on individuals. To thank first and foremost are my two supervisors, Flora McLean and Dr. Camille Baker, both of whom remained alongside my frustrations, revelations, challenges, and breakthroughs. The completion of this thesis is thanks to their considerable investment in my work, overall well-being, and future potential. They ultimately helped me figure out what I have wanted to say for many years, dating back to well before this academic time-frame. From the originating discussions I had with Flora back in 2016 while making some headpieces for a performance, through these years of transforming them into a PhD, she gave me the courage to make things, to experiment, to fail, to wonder, and to communicate through materials, non-linear thinking, and new ways of artistic expression. She welcomed me into a rich and unique community, which I now am lucky to also call mine. She was always there and available when I had doubts (and there were many!), hit roadblocks, and was trying to navigate innumerable waves of imposter syndrome. This freedom was complemented by Camille's total understanding of how artistic research needs to be shaped, written about, and applied within contemporary contexts. It is rare to have so much attention paid to your work over every step of a PhD (while running an entire course, winning awards, and advancing her own practice simultaneously), but I – and this thesis – have been fortunate to benefit from her experience, expertise, and academic acumen. Camille's balanced input, patience, and focus helped orient my inquiries into a body of substantiated research. The integrity of this research was also thanks in part to my advisor in smart textiles, Dr. Sara Robertson, who was there from the start, helping me understand practice-based research and how it can manifest through physical and digital materials.

I would also like to thank my examiners Professor Scott deLahunta and Dr. Michèle Danjoux for their generosity and thoroughness in the feedback and responses. The clarity of their comments was the ideal balance between precision and appropriate flexibility, allowing me to rediscover why I had wanted to do this research in the first place. It is a real gift to have such constructive, proactive, and encouraging insights and for this I am grateful.

Design is about collaboration, and this research has been no exception. Leah Gerber Davis waded through my complex and often unclear questions about algorithms, quantitative data processing, and how to fit a world I had previously thought so opaque into my creative practice. Her openness and willingness to understand questions I did not yet know how to phrase, and patiently probe their uncertainties, has been invaluable for this PhD, and for future practice. Finding ways to translate these abstract conversations into applicable, physically tangible sensations was thanks to some very talented technicians, researchers and creatives at my host institution, the Royal College of Art. Dr. Thomas Deacon opened the world of motion capture technology to me, and was always willing to break down and simplify the complexities of digital technologies in performance. Helping me translating digital data into tangible human sensation was thanks to Dr. John Wild in the physical computing lab, whose complex and abstract thinking continually reassured me throughout a sometimes-unsettled university setting. The non-(or anti-!)-digital components are of no less value, and were strongly supported by the fashion department. It has not only been my academic home over the years, but also provided top-notch technical expertise and creative interventions. Kelly Duncan and Iwona Zabrocka always found time in their schedules, despite their army of masters' students, to help with the garments for my dancers. And, of course, Zowie Broach, who facilitated my integration into her fashion programme, and ensured access to the tools and equipment I needed, no matter how bizarre the request. The multi-disciplinarity of this project would not have been possible without these talents.

Although less directly involved in the direct content and development of this research, there were some key figures who offered inspiration before and during this PhD. Dr. Claire Pajaczkowska was one of the main reasons I applied to the RCA in the first place, asking just the right questions when I was preparing my proposal. Leading the School of Design Research, where I have been based, Dr. Ashley Hall helped me grapple with the complexities of my somewhat atypical design journey. Thank you for sending me to Australia – that visit has proven both fortuitous and serendipitous!

I would be remiss if I did not also thank Studio Wayne McGregor and East London Dance, who helped enabled me to realise my practice through advice, studio time, and access to their exceptional dancers and facilities. Their generosity was complemented by that of the Leathersellers' Company, COATS Foundation

Trust, and Sir Richard Stapley Trust, by opening doors that would not have been otherwise possible. Thank you also to DK&A for your third party sponsorship.

The moral, social and emotional support provided by the Fashion+Textile WhatsApp group from day one has been a lifeline through some difficult times, exacerbated by a global pandemic, and divisive national political unrest, but also by the individual battles many of us face during our doctoral journeys. Dr. Victoria Geaney deserves a special mention for convincing me to apply in the first place, and for being part of this new wave of fashion, textile, material and design researchers. In parallel, the MESH Material Research group, led by Dr. Elaine Igoe, offered the necessary space to question, discuss, and debate what it means to be a researcher and a creative practitioner in this space, within an environment in constant flux.

And lastly, beyond my family the help of some people outside the RCA made the completion of this research possible. Vanda Strachan who, while also completing her own DPhil, tactfully posed some sometimes brutally academically rigorous questions, mirroring what those outside my field might ask. Tina Benson and Sarah Landry Maltais not only provided restorative accommodations; their professional legal backgrounds and interests in artificial intelligence promoted a space to ask so many questions. And, of course, Rafael Rodrigues de Sales, who always checked in, helping me through rough spots and sharing in the successes along the way. They all deserve so much more than these words of thanks for their contributions and personal support.

I thank all these amazing mortals, alongside others I may have missed.

v. VOICE

In sections of this thesis, for certain reasons, I have altered the voice in terms of narrative and tone. The first person is used as the default voice because the choreographic context used to interrogate the research questions has come from my own experience. I also acknowledge my presence as the researcher and creative practitioner leading this Practice as Research[1] inquiry. Writing this thesis from the third person would be like directing the research practice from behind a two-way mirror, and communicating with the participants via other people or other indirect means. While this could also be a viable approach, it is not how I designed this study, and so would feel dishonest. An exception occurs when I position this research within the literature in Chapter 2 (from page 29), although I return to the first person for the subsequent and related chapter on artistic context (Chapter 3 from page 53), permitting its presentation through the notion of embodiment to feel more organic. Given the multidisciplinary nature of my research practice, there are therefore multiple fields to acknowledge to create space for a doctoral thesis. In respect of the array of voices that affect this study, I have adopted the third person to support an objective consideration of their works.

Second, you may note the relatively informal tone of voice from the first person used in the Preface below. I have separated that background information because it happened before this PhD research. However, it is a relevant context considering that the initial concept for this study became apparent during that time. My reflection on this period and the work carried out then also supports the autoethnographic method outlined in Chapter 4 (from page 63).

Last, I have also maintained a somewhat less formal tone of voice for the body of the thesis. This is partly because my background is in industry and creative practice, and not academia. Beyond familiarity, this style of writing has allowed a focus on the content over the stylistic structuring and use of formal academic vocabulary. This is mainly because my hope is that this research will benefit audiences beyond academia. Beneficiaries of this research are discussed in more detail in Chapter 7, Conclusion (on page 106), but those in creative practice and industry form a key target demographic. For this reason, I have visualised this document rather than taking a theoretical approach, so that it may resonate better in the interest of visual learners. I obviously do not wish to exclude text-focused academics and researchers, but I do aim to expand the reach of my creative research practice because it centres on improving the human experience for the future.

[1] Covered in Chapter 4 Hybrid Methodology from p. 63.

vi. PREFACE

While the idea behind this research germinated during my postgraduate fashion degree, this thesis is not simply an extension of that work. I have transposed the concept to a different context and developed it over the course of this PhD. For this reason, and to help situate this study, I have provided some background context in this preface, before moving on to the Introduction in Chapter 1 (page 19).

……..

I have always been fascinated by the intermingling of artforms with technology, but back in 2015 I had not directly considered algorithms related to fashion. The term had come up several times in the previous few years, when I was still working in the fashion industry in New York, perhaps because I was designing private-label menswear for a large-scale corporate retailer.[2] This environment meant that the datafication of my designs through financial planning and the metrics of costing and selling was a daily occurrence. At the time, the company was grappling with omni-channel[3] distribution in a fast-moving market, and trying to establish efficient and economic methods to link their online sales with those from bricks-and-mortar sites. E-commerce was booming,[4] and they wanted to capitalise on this business. Within this race, the use of algorithms to track online behaviour was deployed in an attempt towards targeted marketing to increase sales revenue. I did not stay to see how 'successful' this new initiative was, but it did make me wonder who the actual beneficiaries were in this arrangement. My revulsion towards the spiralling consumerism in fashion that finally tipped the scales too far was the catalyst for me to seek a new vantage point, hopefully for a more positive effect. The luxury of freedom afforded by returning to an educational environment after an extended period in industry allowed a freer contemplation of some of the systemic challenges society faces, explained later in Chapter 2.

It was during this period of intellectual liberty that I experimented with algorithms in the garment design process, employing them to generate polygons with which I draped silhouettes. But, most importantly, it facilitated this doctoral study by enabling me to think about how a similar process could be applied to dance choreography. During my Master's degree I worked with my long-time friend Leah Gerber Davis, a biostatistics and statistics expert, whose skillset to build algorithms complements my fashion and choreographic skills. Our extended online chats (she lives in the United States) allowed me to ask questions about algorithms to expand my understanding, and consider how to integrate them into my research practice. Recalling the algorithmic design process I devised, I mentioned an earlier conversation we had had to Davis: "…remember when we worked on the first algorithm you asked me [a] series of

[2] The name of the major retailer has been omitted to avoid the risk of sharing proprietary information. While not the largest company in terms of revenue, it was considered high profile and in the luxury market. I left in December of 2015.
[3] A retail approach whereby customers can purchase, collect, return and/or exchange goods via any channel: in-store, via the website, via phone application.
[4] 'In 2016, in a single twenty-four-hour period, Alibaba's consumer websites alone handled more than $17.8 billion in transactions, more than the total combined online sales of Black Friday and Cyber Monday in the United States' (Erisman 2017, p.4).

questions to determine parameters?" (online chat, Gerber Davis and Guérin-Garnett 2019). The inspiration for that first algorithm stemmed from my response to a design competition[5] brief which used the abstractive aesthetics of German Expressionism (Elger 2002) to create a garment. During my research, I discovered ciphers and their use in World War II. The Vigenère[6] type was relatively accessible for a non-cryptologist[7] like me to encrypt alpha-numeric information, from which the resulting code could be deciphered with a key.[8] Like the discussions I had with Davis, I was trying to find ways I could navigate unfamiliar territory – in this case, encrypting codes. To do this, I manually visualised my own version using familiar terms from dance terminology and notation (see Figure 1).

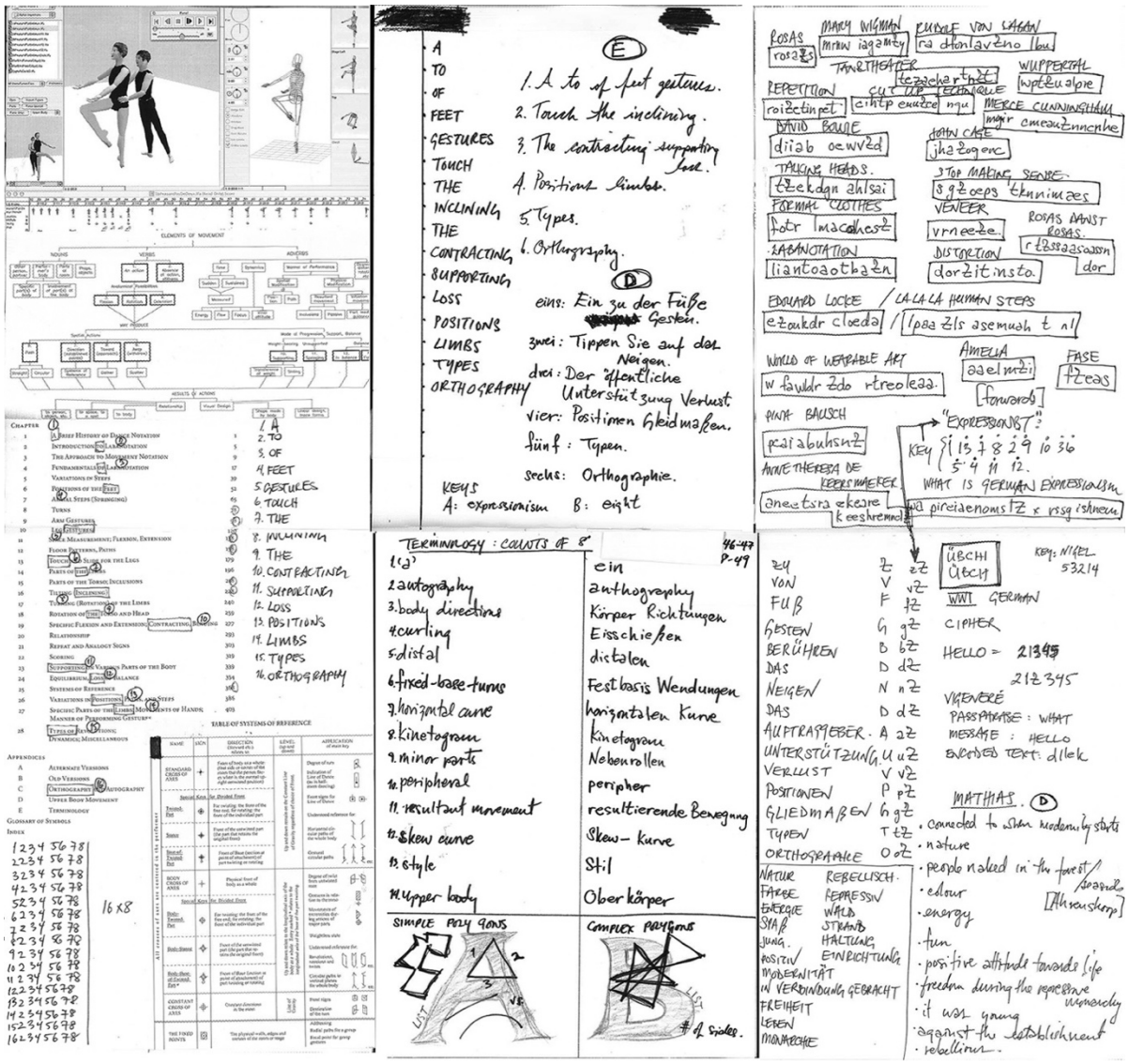

Figure 1: Sketchbook pages showing the cipher exploration process (Guérin-Garnett 2016).

[5] World of Wearable Art 2016 competition, *World of Wearable Art* (https://www.worldofwearableart.com/accessed 13 Feb 2023).
[6] 'In a Caesar cipher, each letter of the alphabet is shifted along some number of places. For example, in a Caesar cipher of shift 3, A would become D, B would become E and so on. The Vigenère cipher consists of several Caesar ciphers in sequence with different shift values' (Nostradamus Wiki online, Description section, para. 1).
[7] A cryptologist is a specialist in secret codes, encoding and decoding messages. I do not claim to be a cryptologist.
[8] '…the key is a word or phrase that is repeated as many times as required to encipher a message. If the key is DECEPTIVE and the message is WE ARE DISCOVERED SAVE YOURSELF, then the resulting cipher will be:

```
Message: WE ARE DISCOVERED SAVE YOURSELF
Key:     DE CEP TIVEDECEPT IVED ECEPTIVE
Cipher:  Z I CVT WQNGRZGVTW AVZH CQYGLMGJ.
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' (Simmons online, para. 3).

Figure 2: Illustration from my sketchbook showing a simple codification process via a Vigenère cipher (Guérin-Garnett 2016).

From there I used an online cipher tool (Akins 2016) to generate six phrases with ‘expressionism’ (A) and ‘eight’ (B) as key terms (see Figure 2). My competition submission included a summary of the process I developed to create a garment (see Figure 3).

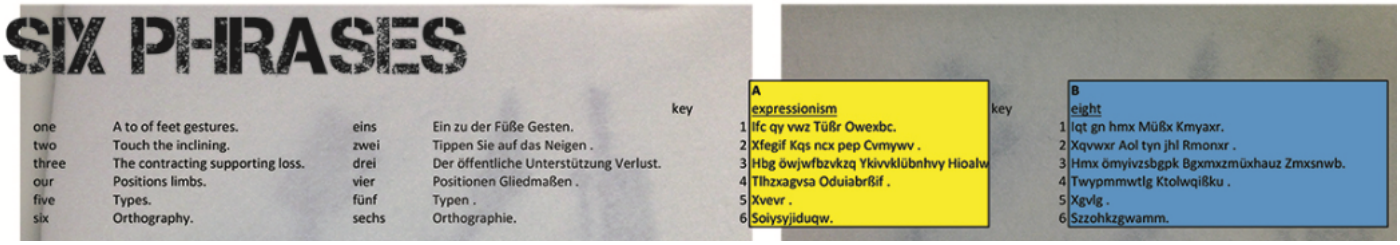


Figure 3: Garment I submitted for the fashion competition (Guérin-Garnett 2016).

Figure 4: Sketchbook page showing draping with polygons (Guérin-Garnett 2016).

Looking back, the creative process I developed in effect formulated the building blocks for this thesis.

Six phrases were created using every eighth word from a list of selected Labanotation terms. […] Because much of dance and movement [is] counted in eights, this choice made sense.

These words were translated literally [into] German. By using two different passphrases, ‘expressionism’ and ‘eight’, via a WW II German cipher (called the Vigenère cipher after the sixteenth-century French diplomat Blaise de Vigenère) these six translated phrases were transformed into two sets of six codes (12 in total).

By allocating different values to the characters, spaces and [cases] of the letters’ numeric associations were created. Parameters were then assigned to an algorithm to create shapes.
These [included] the following: the results would be random: set A would generate simple polygons, and set B would generate complex polygons; a maximum of six shapes per code would be generated, creating 72 shapes in total [...]

As the algorithm's end stage has not yet been finalised ,various polygons were used to create the six designs seen here [see Figure 4] to show the method. But this process stands true and will be updated and adapted once the algorithm is complete for future designs.
The important factor is that the resulting polygons will be unknown and unexpected, continually leading to new designs.

Multiple polygons may be used per design, thereby furthering the number of possible design outcomes. (Guérin-Garnett 2016).

Figure 5: Rudolph von Laban's German Expressionist aesthetic (Dörr 2003, p.3).

This coding investigation also initiated the reconnection with my dance background, which deepened through the creation of *344|142*, a fashion performance I created for four dancers (Guérin-Garnett 2016, and Artrepreneur 2017). The link was created by revisiting my interest in German Expressionism and recognising that dance was included in this ideological shift. One key figure was Rudolph von Laban, who the specialist author Evelyn Dörr cites as the founding father of Expressionist dance (Dörr 2003, 2007). Looking at his photo (Figure 5), it is easy to recognise the severe, exaggerated features inherent to the movement, aesthetics I tried to echo in my final major project. This attraction to the visual cues of that era fostered further investigation into Laban and his notation system, which is still widely used today (Fukushima 2016, D'Amico 2019). Importantly, it refocused my enquiry into algorithms within creative processes towards choreography. I had unwittingly practised body coding methods through my years of Cecchetti ballet classes, simply by learning certain positions in relation to established terminology (see Figure 6). If the instructor said 'à la quatrième derrière'[9] I knew exactly where to place my body in space, for example.

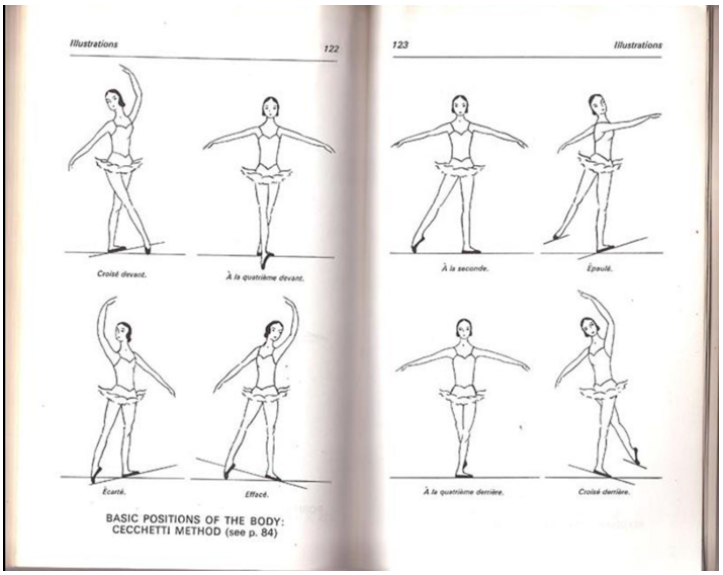


Figure 6: Cechetti method terms for positions of the body (Grant 1967, p.122-123).

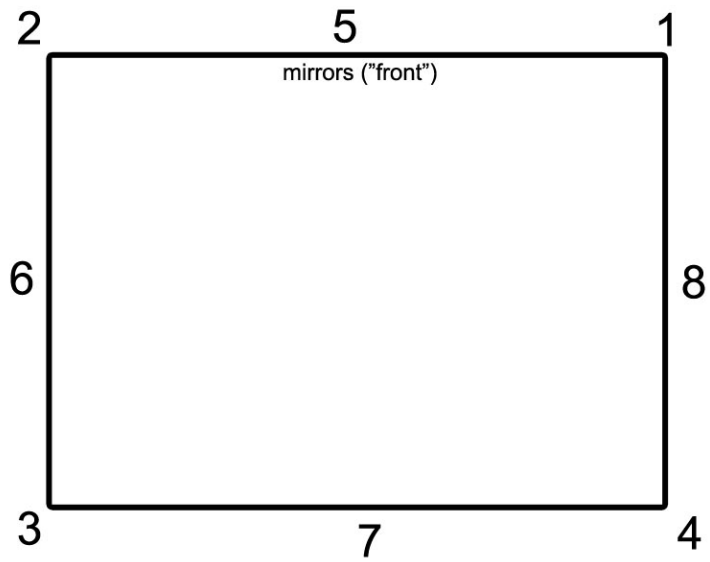


Figure 7: Cechetti method ballet corner numbers (Fraser 2010).

[9] Classical music uses Italian terminology, and classical ballet uses French.

Similarly, if the direction was to begin an exercise from corner '4' and travel to corner '2' (Figure 7) I would have a clear idea of where to start and end in the studio. This was a process of alphanumeric coding a physical human body moving in space. This method, prevalent in formalised dance, allows for a translation of qualitative into quantitative data, though for this research I focus more on digital capture formats, explained below and in the introductory chapter.

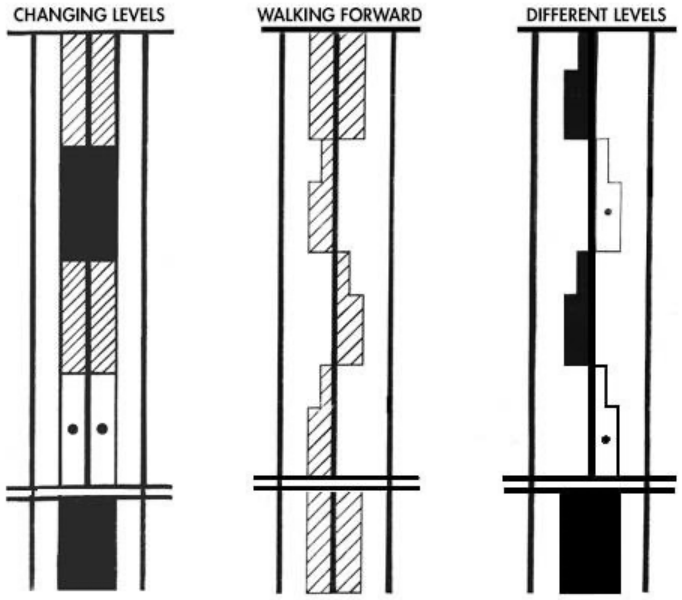


Figure 8: An example of Labanotation showing movement transitions (Kleida 2018).

Although I found ballet overly austere, in hindsight its rigidity enabled a codified, mathematical understanding of the body in motion, and it introduced me to Labanotation. To me, this notation method was an aesthetically pleasing way of writing dance, akin to a musical score (see Figure 8). This fascination returned seventeen years later, when looking at Laban through a fashion perspective produced the possibility of employing algorithms in choreography. Although my understanding of algorithms has expanded throughout the course of this PhD, I am not an expert, which is why I reached out to Davis originally. I recognised a limit to my skillset that could not realistically be conquered while exploring the central disciplines of my practice: fashion and dance. Although I have employed other forms of computer technology in my professional practice (such as Adobe Illustrator, Photoshop or scanning software), algorithmic construction was beyond my capabilities. I therefore sought to collaborate with Davis on this missing aspect to determine how I might adequately integrate them into my work, following my already established algorithmic design process. It has also proved helpful to have a collaborator who is well versed in poking holes in hypotheses and theories. Davis explained that biostatisticians are commonly involved in medical research, and part of their role is to ensure scientific integrity by asking such questions, because human lives can be impacted.

Once I had progressed beyond the preliminary steps of this research, I revisited this subject with Davis with a specific focus on dance choreography. During one of our discussions (see Appendix IV on page 133) I was attempting to locate the role of data in my work, explaining that '[…] the interesting bit is that this technology can create data from the movement sequences I devise' (Online chat, 13 April 2019), when referring to the OptiTrack[10] motion capture system accessible through my university at the time. Outlining the capabilities of this technology to Davis, I proposed that 'I think the concept of robotics, AI, machine learning, data sets being recorded by giants (Facebook!! websites, government, etc.) needs to be

[10] OptiTrack is one of several brands that produces the software and hardware used to digitally capture movement. See MoCap in Section 1.5 Key Terms on page 23.

interrogated more thoroughly than it has been [...] We need to catch up [on] the ethics of the value of data and why it is so [profitable]' (2019). While this was purely a statement, it crystallised the motivation behind this investigation into algorithmic applications in creative processes. As my experience in dance and fashion is embodied, I inherently consider the effects of these technologies in relation to the body. From this perspective, this research has developed my earlier remark into a thesis through a choreographic practice.

vii. INTEGRAL MATERIAL

This thesis represents the written component of my practice-based research. However, the practice I have developed through this PhD forms the central argument of the research, which seeks to address the research questions towards an original contribution to the field. I have entitled this section 'integral' instead of 'supporting' material, because I do not consider the practice as subservient to this written thesis. As explained further in the introduction to Chapter 1, this research is interdisciplinary, sitting between three subfields: human-computer interaction, body-tech, and dance choreography (see Figure 10 on page 21). The physical and digital making processes I carried out inhabit their point of intersection, and constitute the focus of this research project. Due to the varying nature of my multi-methods approach, a portfolio incorporating the following elements has been included alongside this written thesis as follows:

1. An illustrated dossier with still photographs of the body-tech/garments I developed and some of the fittings I carried out between December 2017 and August 2022.
2. A 1:16 minute video explaining the concept and functionality of the technology that was eventually embedded in the garments to activate movement in the research participants.
3. A 10:02 minute video summarising the choreographic practice carried out during this PhD research.

Beyond the above, supporting materials that have been directly referred to in this thesis document are included in the Appendices, from page 120 to 175.

1 INTRODUCTION

To introduce this thesis, in this chapter I will outline the main arguments, the impetus behind this research, and lay out the key concepts involved as background. In response to these motivations, the research aims and questions are provided and contextualised within the interdisciplinary nature of the research by diagramming the relevant domains, and more specific subfields, thereby situating this enquiry within the wider field of choreography. Given the different disciplines involved in positioning this inquiry, I define some key terms, some of which can be cross-disciplinary, for orientation and the avoidance of confusion in subsequent chapters. I then outline the systemic philosophy from which I consider the research questions, before concluding with the projected originality of this investigation. Now let us first consider first principles of the context from which this study explores the effects of digital technology on the body: dance.

1.1 Weight Transfer and Context Shift

The first principle taught to students in ballet class is the transfer of weight. As all formally trained dancers have learned, I control my alignment from one leg to the other, but here I am using this lesson as a metaphor to illustrate the shift from algorithms within garment design (as outlined in the Preface, page 12) to choreography. Shifting from the former context to the latter marks the beginning of this research.

Contemporary dance offers a rich context within which to investigate human-led integrations of artificial intelligence (AI) in society, thanks to its inherent corporeality within the context of its creative process. Focusing on the human body, this research considers the potential impacts of intelligent digital agents (see page 23 for Key Terms) within creative processes, using choreography as the medium. By extracting the fundamental arrangement of such a dynamic, the potential of a human–non-human–human communication method may be envisaged. This method can be viewed as a non-linear, living architecture that enables an exploration of the agents encased within its system design. It is alive in that living human beings are part of the structural layout, and it is architectural in that it is concerned with the relationship between the human body and its environment.

Developed over the course of this doctoral study, my choreographic system design assimilates artistically intuitive and digitally-based computational inputs to connect through physical instigation. My human impulses can be sent to another human via a wearable embedded with a physical computing device to elicit their physical interpretations. Given the choreographic context I have used, the sender can also be called the choreographer, and the receiver called the dancer. Through the performance of this system, I propose that the resulting technologically affected material may promote questions about recent advancements in artificial intelligence (AI) within creative production, in view of a rebalancing of the information economy[11] (see also Section 2.2 on page 29).

[11] The economic system in which the majority of contemporary global society exists. The currency is information, often in the form

Referring again to the dance lesson metaphor, this research is positioned as a form of counterbalance, to challenge the increasing deployment of data collection technologies, such as human gait recognition, for corporate gain. This particular development goes above and beyond those already present in our everyday lives, such as facial recognition and eye tracking. Our digital behaviours are becoming increasingly managed by the privately owned Big Tech organisations that dominate the technology service provider space. Such developments promote the dominance of such organisations, which now present the possibility of physically affecting our bodies in the process. Our grasp of the actual impact is currently limited, requiring greater understanding for the preservation of our personal freedoms, privacy, and data ownership.

1.2 Research Aim & Questions

Given the motivations outlined above (and in the Preface), the aim of this research uses the body as a centre of knowledge to investigate how the intersection of dance choreography, body-worn technology and digital technologies may contribute to an understanding of the potential impacts of artificial intelligence on our corporeality. With this aim I established objectives, which were to:

1. Create a set of custom body-tech apparatus that can inspire movement in dancers;
2. Send sequences of digital information to those apparatus using computational devices;
3. Create new choreographic material through this remote system design with expert users;
4. Learn from their user experiences through a series of workshops devised to understand their preferences for prototype development; and
5. Draw from the collection of methods employed to transform the findings into tangible insights that may inform more ethical means of integrating AI agents into creative processes using choreography as a context.

One **main** and two supporting questions offer a focus to address the aim and objectives of this investigation, which were:

1. **What can dance choreography reveal about AI touching our bodies?**
2. How can digital data materialised via physical computing devices affect dance choreography?
3. What impact might this technology have on participating dancers?

of digital data, whereby those that generate such data become the resource.

1.3 Roles & Collaborators

Choreographing is an artistic act that often requires different agents within its creative process. For this research project I have taken the role of choreographer and researcher, working with two dancer participants. Through an East London Dance award, I was able to collaborate with dancers from Company Wayne McGregor, and carry out the central research practice in their purpose-built premises. Considering the multiple variables intrinsic to the interdisciplinary nature of this work, building from a common physical and verbal vocabulary was important. Our similar dance conservatoire backgrounds and interest in the digital-physical dynamics of contemporary dance enabled a deeper enquiry and fostered a fruitful research environment during our exploratory sessions. The participants are presented in Section 5.7 (p. 82) that details the practice activities I carried out. Physical computing, motion capture and fashion technicians also supported my practice, and they have been mentioned in the acknowledgements. Although the practice elements of this research were sometimes collaborative in nature, I planned, led, analysed and discussed (herein) these activities for the purposes of this research project.

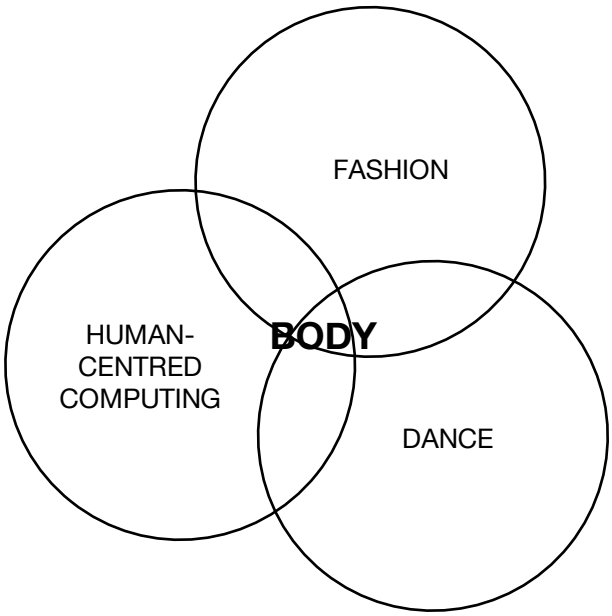


Figure 9: Broader disciplines of this research.

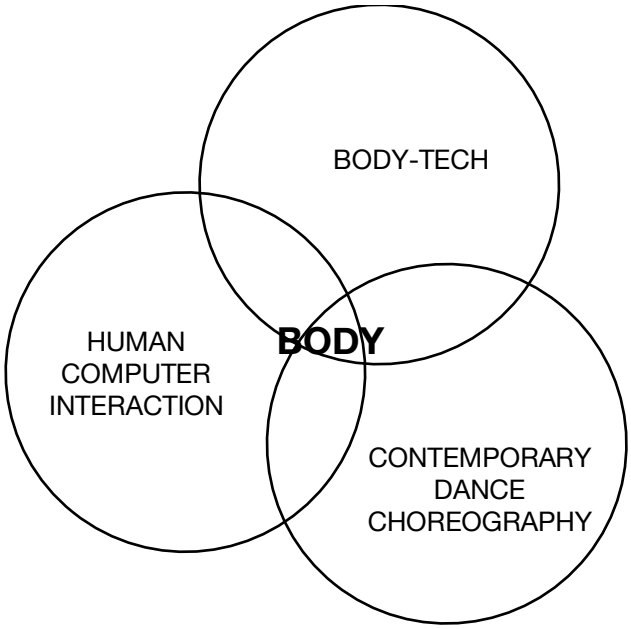


Figure 10: Subfields of this research.

1.4 Diagramming Disciplines

Given that this research uses an interdisciplinary vantage point, using the body as a knowledge source (detailed in section 4.4. on page 67), and that each discipline employs an array of vocabulary, here I define some key terms in connection with this positioning. Figure 9 represents the larger domain areas in which the subfields diagrammed in Figure 10 live. I delineate them as follows: (a) contemporary dance choreography is a specialism of dance; (b) human-computer interaction sits within human-centred computing, and (c) body-tech is a subcategory of fashion.

a. Dance | Contemporary Dance Choreography

This is the context and the method I use for this research, which is partly why it is has become integral to the contribution this study proposes. It is a creative process of which I have first-hand experience, so I have used this knowledge of practice as a basis to interrogate our relationship with learning algorithms, to eventually shed light on the application(s) of artificial intelligence in creative processes.

Although I use it specifically in a dance-making context, choreography is not relegated strictly to being an art form and can be more broadly defined as '[…] the purposeful arrangement of sequences of motion' (Crnkovic-Friis and Crnkovic-Friis 2016, p.1). Broadly, it is '[…] an art largely based on physical expression and embodied knowledge' (2016, p.4).

b. Human-Centred Computing | Human-Computer Interaction

> We still have the challenges of changing the attitude to design and development methods. It seems strange to me, because I've been talking about it for 50 years, but nevertheless I still see many examples of poor design and development methods, not taking human beings properly into account. (Mori 2023, interviewing Ernest Edmonds).

Edmonds' quote is in response to being questioned 'about the future challenges and opportunities in HCI' (Edmonds 2023, p. 18-19), or human-computer interaction. I have opted for this term to describe the discipline in which part of this research operates. HCI is also considered to be *an aspect* of Human-Centred Computing, which is why I use HCI as a discipline within the broader domain of HCC to situate this research more specifically. For example, the humans in this study are the dancers and me, whereas the computer is the Arduino we are interacting with during the choreographic workshops.

c. Body-Tech

Instead of using wearable design here, I have further carved out body-tech – meaning human body-worn technology – from the broader concept of fashion. I still consider it to be a form of design applied to the body, but because this design type acts mainly as a structural exoskeleton delivering vibrations to the wearer (in this case dancers) via a combination of accessory/garment and physical computing, I position it within the discipline of fashion (or indeed design for performance, when specifically situated within this context). However, in this thesis I have intentionally avoided using the term 'fashion' for two reasons: to avoid confusion and because this research does not directly address the evolution of this field or specifically interrogate its definition in a contemporary context. While the apparatus I have built through this research practice could also be a form of accessory design which is more easily associated with fashion, the inclusion of physical computing in their construction positions the pieces more accurately in the category of body-tech.

1.5 Key Terms

Agency

In this context I use ‘agency’ to mean the notion of the impact on a system, environment or situation by a given actor (or agent). Having agency would mean possessing the power to affect the other actors within these contexts, the degree of which may be variable. This also pertains to the ability to choose relative to the control of oneself or others, whether these are human, non-human, individual, collective, or organisational entities. In other words, if I have no agency (or feel as such) within a creative process involving several collaborators I cannot affect its direction or outcome(s) of my own volition; the results are influenced by other agents, but not me. I connect agency with this research specifically in the concluding chapter on pages 104 to 108.

Algorithmic Integration

This is the act or process of integrating a digitally supported algorithm into a creative process involving human agents such as a researcher, choreographer, participant, or dancer, which is usually an analogue one. For example, contemporary dance choreography that does not employ any form of digital or other non-human technology to create dance sequences.

Learning Algorithm

[Chapter 2 on p.29) also discusses AI and algorithms in more depth.]

Learning algorithms can take different forms, but they are usually generative and use (forms of) machine learning. Here I have used the overarching term ‘learning algorithm’ to denote a digitally-based algorithm capable of learning from its outputs. An example could be the algorithm in a smartphone that ‘learns’ the user’s typing input patterns, to predict and suggest the most logical autocorrections for spelling and grammar.

Artificial Intelligence

[Again, Chapter 2 expands on AI.]

Briefly, I explain that AI is currently used as an overarching term that has several meanings, some of which are not completely understood by the general population. We can loosely consider AI to mean a digital machine capable of making its own decisions, and learning from its own and/or others’ behaviours.

(Intelligent) Digital Agent

An agent within a system that is digitally based, requiring at least a minimal level of computational capacity for it to be active. It may exhibit intelligent, or intelligent-like, behaviour if its computational activity is informed by some version of artificial intelligence. In the case of the choreographic system I have built during this research process, the Bluetooth- or Wi-Fi-enabled base attached to a button is a digital agent. If this was instructed by an AI, then we could consider it to be ‘intelligent’; however, in its present guise the intelligence comes from the human activating the button.

Machine Learning

A group of computational algorithms used to 'learn' through patterns and/or online user behaviour, for example, to (supposedly) improve the efficiency and effectiveness of those algorithms' original intent. This given set of algorithms have been 'trained' on existing data to be able to perform a given task such as pattern identification. This technique is used in facial recognition: for example, in Apple iPhones that can scan a face to recognise certain facial features, thereby acting as a key to unlock the owner's device. The software has been trained on millions of faces using machine learning, so that it can identify the owner's face as different from others.

Systems Thinking

Linked to the systemic philosophy described below in Section 1.6 (on page 26), this is an approach to considering problems or scenarios to gain understanding. While those such as Peter Checkland have published widely on this approach, I use the term more loosely, building on the years I spent working in the fashion industry. This stems from the requirement of practitioners in this field to have a firm grasp of how a global supply chain functions and exists in a constant state of fluctuation across time and geographical location. The exception could be if you are working in an haute couture atelier, which has a different structure, in which most product creation functions are often in the same physical space.

Checkland describes systems thinking as '[…] consciously organised thinking using systems ideas' (Checkland 1999, p.45), when laying out the principles of Management Information Systems (MIS). However, I adapt his definition in that this way of thinking is not always conscious for me – it appears instead as a state of being, almost as though it cannot be switched off. In this way, I claim that my experience in the fashion industry over several years has influenced the way I think about most things in my daily life, including dance choreography.

Graham Technique

[See also Section 5.1 on page 71 for examples related to this thesis.]

Established by the dancer and choreographer Martha Graham, this is a technique that is still taught and practised today.[12] This technique is well documented and has terminology for each of its movements and stages within the technique class, much like classical ballet.

Although first inspired to make dance her profession by ballet dancer and choreographer Ruth St. Denis, Graham eventually veered away from the Denishawn[13] teachings and choreographic material, which probably helped to inspire Graham to develop her own technique and style (Aubrecht, citing Horosko, 2017, p.85). It was when Graham was appointed as head of the dance programme at the Eastman School

[12] The Martha Graham School has existed since 1926 in New York City, and is credited as the oldest professional dance school in the United States.
[13] Ruth St. Denis and Ted Shawn founded the Denishawn School in 1915 in Los Angeles. The institution is considered a fountainhead for American modern dance.

of Music that she really evolved her own version of dance with selected pupils. While she emphasised the 'contraction', the 'release', and the 'spiral' as pillars of the technique, their actual origin remains the subject of debate. Jennifer F Aubrecht argues that 'It is important to note the use of yogic breathing techniques in the development of an otherwise Christian expressive discipline, as it demonstrates the international circulation of movement practices long before Graham's use of *kundalini*[14] in modern dance technique' (Aubrecht 2017, p.91). Connections between the Graham technique and yoga have also been explored by Eileen Or. She points out that in yoga 'the act of inhaling is negative or passive, since we are merely receiving the life-element of "prana"'. Exhaling, on the other hand, is positive and active, because 'we are giving, radiating, distributing the energy we have taken in to all parts of our bodies' (Or 1995, p.206); (Reynolds 2002, p.16). Scholarly study of the influence of yoga on Martha Graham have also come via Horosko. Crediting Graham with the re-classification of yoga techniques, she claims that 'Yoga-like breathing was introduced into the classrooms of Western dance at the turn of the century, [but] Graham was the first to develop the contraction and release principle into an inherent principle of movement in her new dance form' (Aubrecht 2017, p.86).

Arguably more specific to the Graham technique is her integration of the spiral in close conjunction with the contraction and release. It is not twisting per se, but has a clear distinction in that it expands and extends through the spine upwards throughout a movement. The contraction is something that takes considerable time and practice to 'find' in the body. A teacher cannot make the student's body do it for them, but they can provide the tools and foundations around it for them to locate it themself. It often tends to begin in places in the centre of the body that are different in male and female dancers, because of their anatomical build. For clarity, the 'centre' of the body is not the even crosshairs of the X and Y axis of the body. It is the gravitational central powerhouse (Aubrecht's version of kundalini) of the body that, when found and understood, allows dancers to move across all axes in complete control. A considerable amount of formal (ideally conservatoire-style) dance training is usually required to master the centre, and it is generally after this that the contraction can be discovered. A release always follows the contraction, and radiates both upwards and downwards from the location of the contraction. The important aspect to grasp is that none of these tenets are fixed movements with static beginnings and endings. Instead, they are almost like breathing, manifested throughout every sinew of the body in a continual and varying internal bodily debate. The contraction, no matter how big or small, resonates outwards through the body from the centre, beyond the physical limitations of the extremities. The release is like the elastic that brings it back in so it may begin again.

Improvisation (in Dance)

This is a common method used in choreography to develop new material, and one that I use throughout the Choreographic Workshops which are described in sections 5.8 to 5.11 (on pages 83 to 90). While retaining a certain level of dance technique is required minimum to avoid injury, this method provides a

[14] Derived from Sanskrit, kundalini is often explained as a 'coiled snake' of feminine energy located at the base of the spine.

licence to allow the body to move in any way the participant wishes. Sometimes there are prompts provided (as I offered to my participants) or other techniques for inspiration are employed (like music), but the general aim is to discover the unexpected. In her thesis, Katie Rees (see also section 3.4 on page 59) also cites Blom and Chaplin's version of improvisation in their book *The Moment of Movement: Dance Improvisation*: 'Dance improvisation fuses creation with execution. The dancer simultaneously originates and performs movement without preplanning. It is thus creative movement of the moment... allowing spontaneous and simultaneous exploring, creating and performing,' (Blom and Chaplin 1988, p.6; Rees 2022, p.22).

Point of Initiation

An essential building block in formalised dance training is understanding the point of initiation for a movement in the body. When mastered, it is understood as the necessary control of physical impetus in the body. Often imperceptible to the viewer, this moment begins deep in the body's musculature and structural alignment, sparked by a neural signal. Tempered through muscle memory learned over years of training, it can manifest precisely as the initiator (a dancer in this case) intended. The process of 'listening' to the body and where this point of initiation for movement is coming from is often the result of extensive training and practice. This point of initiation moment was explored in detail through the choreographic workshops carried out in this research, described from pages 83 to 90 in Chapter 5.

MoCap

This abbreviation of motion capture refers to different systems used to collect the data generated by three-dimensional movement in real time and convert it into digital form. This tool is also referred to as performance capture when it also includes capture of the full body, face and fingers. In this context it is used in animation to give a lifelike quality to computer-generated two-dimensional characters in television and film. There are markered, markerless and inertial types of MoCap systems. The first usually involves placing markers on the body, whose placement in motion can be picked up by a series of infrared cameras mounted around a room. Markers can be attached with Velcro to a suit that is worn on the body, or by using straps. Markerless systems use standard digital cameras, often leveraging deep learning software systems to locate and identify the body moving in space. Inertial systems generate motion capture data using inertial measurement units (IMUs) with sensors placed on the body to locate their position in space relative to the cameras.

In the early stages of this research I tested the Rokoko suit and OptiTrack MoCap system. These are explained further in Section 5.2, Corporeal Digitisation (page 73): I wanted to understand what it would feel like to have my body represented digitally on screen in front of me while I moved.

1.6 Systemic Philosophy

The systemic philosophy from which I navigate most problems has most likely been informed by the thirteen years I spent working in the fashion system, which altered my understanding of the world. This is

partly because the industry is global in scope[15] (Chuprina et al. 2020), which required systemic thinking across geolocations and timelines for me to execute my roles within the contexts of my fashion practice, employers, and clients. That period also helped shape my systems thinking into a systemic philosophy, which developed into the theoretical basis from which I approach tasks and challenges.

I have developed this approach through systems thinking (as described above) because for me choreography is about relationality. I am not referring to relational theory, sometimes associated with international relations, but I am aware of the possible parallels that could be drawn from its attention to agency (Kavalski 2023). Rather, the relationality I mean supports my way of viewing the world through an interconnectivity of nodes,[16] sometimes in motion, within a system. Within the central context of dance choreography of this research, the knowledge generated is embodied via the movement practitioners' bodies during the creation of material. However, the physical thinking process I and the participants carry out can be likened to Scott deLahunta and James Leach's proposition that '[…] "thinking with the body" is a way of exploring the world and what it is to be human within it' (deLahunta and Leach 2017, p.464), despite their perspective being more anthropological than mine. I see the choreographic process as constructing relationships between people, spaces/environments, objects, joints, body parts, and other sensory influences like sound/music. And in the case of this study, I employ the systemic philosophy explained herein to study the relationship between human bodies and physical sensations created by non-human actors such as vibrating motors mounted in accessories.

1.7 Multi-Methods for Originality

As this study acknowledges the speed at which AI is permeating society, I have employed the systemic approach described above, and with which I have become familiar, to grapple with this complexity. Elaborated upon in Chapter 4 (from page 63), under the umbrella of Practice as Research (PaR) I have created a hybrid methodology using a multi-method approach. Building from my background, elements of radical constructivism, ethnography, choreography and artistic intuition have all been employed for this research. I drew from these methods to challenge the data-gathering inequality generated by Big Tech companies through designing a choreographic system, co-developed with dance artists. By creating a unique architecture mimicking algorithmic integration within its construction, the system I have built presents the possibility of creating *with* AI and the body, to challenge models that favour corporate gain over the corporeal preservation of identity. Echoing Edmonds' recent sentiments, my new system design proposes a framework that places human beings within the design and development process of emergent technologies that employ AI.

[15] Between 2002 and 2015 fashion design, development, production, and distribution was generally achieved via global supply chains for the middle-range and premium markets in which I worked.
[16] A point in a network of a system. Depending on the system type the nodes could be identical or different. In the system of choreography, they would be the dancers. Or in an academic system, the nodes might be the students, professors, institution, faculty, school website, or tools to make things.

The originality of this system is enriched by using dance as a medium for a deeper understanding into how developments like AI-powered body tracking can impact our biological selves. To gain insight and raise awareness of these developments, the system I have devised provides physical instigation to the participant by imitating the kind of instructions an algorithm could provide. The physical computing apparatus built for this research (shown in Chapter 5, pages 75 to 81) provides vibrating stimulation to the wearer via small motor actuators to influence the physical interpretation of the dancers participating in this study. The different patterns of the vibrating sequences ask the wearer to respond through movement. Using ethnographic methods, their improvisations were observed and recorded for consideration, discussion and development through discourse, interviews, and audio and video documentation. Furthermore, the purpose of the system is not only to generate new material; it may also be applied to existing repertoire to create new versions. To address the research aim of exploring the effects of such digital technologies through choreography, the participants' experiences have been embedded into the design and development process, again acknowledging Edmonds' lament.

With the aim, questions, systemic philosophy approach, and adapted methodology outlined in this introduction, in the next chapter I will situate this research by describing and discussing some relevant systems, literature and technologies.

2 TECHNOLOGIES & RESISTANCE

2.1 Introduction

Transitioning to the third person voice for comparative objectivity, this chapter locates this research within the socio-political-economic landscape of the development of technology. To complement this positioning, the following chapter provides an artistic context by contexualising some key practitioners, researchers, and artists who are working in areas adjacent to the research. The types of references pertinent in situating this study vary in format in that they are complex systems, forms of technology and related texts, which all overlap and interrelate, hence the chapter title. The complementary contexts herein cover the information economy fed by data collection, and the laws and legislation surrounding these systems. Shifting towards digital technologies and their impact on daily life, facial and gait recognition are included, and then a comprehensive view on algorithms and AI is offered. The inclusion of these topics is to help identify a gap relative to the research aim of increasing the awareness of corporeal data capture technologies for corporate profit, looking to dance as a form of resistance. To correlate those two ideas, we must first consider the currency from which value is derived in our digitally-mediated world.

2.2 The Information Economy

Using the systemic philosophy approach employed for this research, an imbalance related to our present information economy becomes apparent. This is not a new term: Marc Uri Porat and Michael Rogers Rubin's report *The Information Economy* dates from 1977, for example, and the phrase has since been applied to different contexts. In this thesis I refer to Hand and Lev's definition: 'Silicon Valley entrepreneurs are drawing on computer and communications infrastructure to transform the world's economy' (Hand and Lev 2003, p.48).

A decade later, the computer philosopher Jaron Lanier contrasted historical and contemporary human interactions with technology during a public television interview about his book *Who Owns the Future?*, suggesting that '[…] the original Luddites were neither opposed to technology nor inept at using it. Many were highly skilled machine operators in the textile industry' (Lanier 2013). Discussing the way Silicon Valley supercomputers[17] amass consumer data with no financial benefit to their users, Lanier explains:

> …you might get free music but the possibility of you ever becoming a self-sustaining musician becomes more and more reduced. You might get free lessons but the possibility of you ever becoming a teacher becomes more and more reduced. Eventually this will apply to every profession because everything will become more and more software mediated as we get better at technology in this century. (2013)

Interestingly he uses the word 'better', which begs the question: does he believe the advancement of technology is positive for humanity? He goes on to say that '[…] in 20-30 years robots will be driving the

[17] He is referring to the mainframe computers owned and run by the Silicon Valley "Big Tech" companies: for example, Facebook (now Meta), Amazon, Apple, Netflix, Google (now Alphabet), also referred to as FAANG.

trucks and cabs, and mining for minerals. Yet every bit of data that drives those robots will come from real people' (2013). This is somewhat optimistic, but it should be acknowledged that it was said several years ago. The robot data driver he mentions is AI powered and has since evolved significantly (see further information on AI in this Chapter 3 from Section 2.11). However, the rate is such that when this thesis is published some of the AI advancements reported will already be out of date. I include some emerging developments in AI to mitigate the impact on this thesis.

Perhaps more hopefully, in his book Lanier proposes adding a levy to supercomputers wanting access to user data instead of imperceptibly offering internet-based services 'for free' (Lanier 2014). He suggests that a re-balancing of this system would result in a better economy and less class inequality. Although some people may agree, I would not suggest that the general population are philosophers of computing or approach the awareness of Lanier, considered to be a founding figure in the development of virtual reality. A growing proportion of society is not aware that their harvested data *is* their payment, nor do they appear to care enough to challenge the increasing monopoly of the supercomputers.

One such supercomputer is Meta, which owns and operates Facebook, Instagram and WhatsApp, among other social connectivity software technologies. Building on Lanier's reference, it has been observed that 'Over the last decade, social media use has skyrocketed: Facebook's platforms alone featured 2.9 billion monthly active members as of the third quarter of 2021, making this entity the largest social network in the world' (Kraus, Kanbach and Krysta 2022, p.2). It is difficult to imagine the amount of user data that this single supercomputer has collected over its 19-year history with this number of current monthly users, but the process continues through our ongoing engagement with its platforms. It is easier to envisage the power possessed by Meta's CEO Mark Zuckerberg and his board of directors within a relatively unregulated landscape, however. With its business model, Meta has been acquiring our data, employing its algorithms to 'learn' from those data points gained through our usage, and transmitting them to digital advertisers in exchange for financial compensation. In 2021 alone Facebook made $US39.37 billion in net profit (Statista, 2022). In a relatively unregulated market, technology corporations are less restricted in the tactics they can develop and deploy to increase the information they collect, including our corporeal data.

2.3 Legislation

Lawyers interpret laws, and government officials establish them via the means determined by the system of government in which they function. In the case of democracies, the population votes for leaders who draft and propose bills, which may then be validated into legislation. A critique of the democratic system is not the focus of this thesis, nor is it relevant; however, the weight of this system can partly explain its sluggishness. It is the disparity between the speed at which it operates and the rate at which technology is being deployed that poses a conundrum.

Generally, governments and privately-owned supercomputers cultivate working cultures that are advantageous for their end goals. While the focus of this thesis is not the nature of capitalism in contemporary society, I will use this as an example here to discuss legislative systems in comparison to the advancement of Big Tech companies. The United States favours a growth model, in which an increase in the country's capital is said to benefit its population. Meta is a for-profit business, structured so that its net financial growth increases the dividends of its shareholders, and allows the company to maintain its operating costs (including those of its employees). In other words, while the former is concerned with establishing regulations by which to govern a geopolitical population for its collective benefit, the latter lays down corporate rules to administer its workforce at the behest of its management, with the aim of growth. These theoretical frameworks are inherently different in their fundamental objectives. In the case of Meta, its preference for innovation has produced some pitfalls. In December 2019, a former Facebook employee[18] recounted an experience in which a colleague in another department circulated a company-wide suggestion for a blood drive. Blood donation was voluntary, but its perceived value might have boosted Facebook's public reputation, in view of acquiring new users or attracting potential recruits. Incidentally, the 2020 Facebook diversity report states that, "Our LGBTQ+ community makes up 10.6% of our US-based workforce," (Williams 2021, under 'Increasing Representation Among Facebook Employees'), in contrast to the 5.6% of the American population who identified as such in that same year (Jones 2021). The US Food and Drug Administration (FDA) licensed the first commercial blood tests since at least 1984 for screening the national blood supply. However, the Centers for Disease Control and Prevention documents the AIDS epidemic in the US from as early as 1981 (CDC 2021). Yet it was not until 'December 2015, [that] the […] FDA moved from a lifetime ban on gay and bisexual men donating blood to a deferral of one year for any man who has had sex with another man [MSM] during the past 12 months'. And only 'on April 2, 2020, the [FDA] announced that it was updating its policy regarding blood donations from MSM, reducing the deferral period from 12 months to three months' (Human Rights Campaign 2021). Although not restricted to the Silicon Valley geographical area, this demographic was barred from donating blood for decades amidst fears of the AIDS crisis. Facebook's 'ask forgiveness later' culture appears to be misaligned with their 100 per cent Corporate Equality Index (CEI) rating, or their inclusion in the list of the best places to work in terms of LGBTQI+ equality (Human Rights Campaign 2021).

These organisations can operate like this because legislation has not yet caught up with their business models. Their activity is still relatively uncharted territory, and regulations do not yet exist to govern their innovation methods, irrespective of any perceived infringement on human well-being. In the example of Facebook, the shareholders earn from the communities on which they depend for technological advancement. The economic gain from increased user engagement acquired via advertising revenue takes precedence.

[18] Although a quote was requested after this employee had left Facebook, they declined, saying they did not want to harm their company's image. This renders the point anecdotal, but as it was a direct account I propose it as context to shed light on the Facebook working culture.

2.4 Data Collection

The revealing effects of the disparity in the rates of development between regulation and technological innovation can be seen in tax legislation. Despite having a global usership, Meta Platforms Inc. is registered in Delaware (Zuckerberg 2021), and currently pays tax on corporate income to the United States economy. Analysing this on an international scale, a Facebook user based in India will have their behavioural data harvested through Facebook's platforms while they use the service. That user's data will be transformed into hard currency when Facebook sells their data to digital advertisers. The advertisers will use that data for their benefit to target their ads on Facebook platforms for an increased chance that users will make purchases via these channels. The user is sold the idea that their access to the Facebook service is 'free', and yet their presence on Facebook platforms generated income for Facebook and its contracted advertisers. This revenue generates tax that will go to helping citizens and services in the United States. They will not directly benefit the Indian economy, or the user based in India, although it was they who 'paid' (with their personal data) in the first place (BBC News 2020).

Social media platforms are not the only supercomputers to be built on this business model. Search engines like Google place cookies on our digital activities to help them determine what advertisements to show us during our subsequent movement through their search engine. Advertisers pay Google based on various KPIs (Key Performance Indicators), such as the number and location of clicks per visit, the length of time spent on the advertiser's page, and the rate at which such factors convert into a financial transaction (conversion). Google's user profiles expand in size and accuracy the more we use their services, which are presented as 'free' to use.

However, privately held supercomputers such as Meta are not the only 'farmers' harvesting user data. Governments are now also collecting, processing and capitalising on human-generated user data. Through similar techniques, governments are also collecting and storing data on its citizens' digital behaviour. Research consultant Keith Kirkpatrick explains that '[…] [t]here are very few legal limits on what governments can do with even the most personal data once they have it', further clarifying that '[…] there are no usage or time limits to what the U.S. government can do with that data'. (Kirkpatrick 2020, p.17). These policies are not confined to the US government, either. The scope of the UK's 2016 Investigatory Powers Act (Gov.uk 2016) extends to the point where '[…] the police can download cellphone data without a warrant, and news reports indicate that cloud extraction technologies provided by companies such as Petah Tikvah, Israel-based Cellebrite and Alexandria, VA-based Oxygen Forensics can enable law enforcement agencies in the UK to continuously track social media accounts, as well as using facial recognition to analyze data extracted from the cloud' (Kirkpatrick 2020, p.16). Such intrusiveness appears incongruent with the seemingly democratic systems of government in these first-world Western nations. To navigate the establishment of these digital activity policies we must consider the legislative and legal systems that regulate their attitudes towards these technologies. Increasing awareness of these

developments plays a vital role in addressing the behavioural shift required to hold governments and global corporations accountable for their actions.

2.5 Facial Recognition

Irrespective of the system in play, our behaviours are being 'datafied' through our engagement with digital devices. One data-rich capture technique is facial recognition technology. Digital cameras embedded in computer equipment can identify and track the individual conduct of our facial movements through image analysis. Marketed as a highly secure method, because it uses our unique characteristics, facial recognition technology now permeates most countries and digital devices. It was used to help identify (and eventually kill) former al-Qaeda leader Osama Bin Laden (Reuters 2011). The same technology is used to identify us in a crowd or go through passport control. The CCTV (Closed Circuit TeleVision) that exists across the UK carries out the same process, the only difference being that the surveillance footage is not normally intended to be broadcast publicly. Although an Operational Requirement[19] is needed in the UK, to 'allow […] an organisation to identify the need and intended purpose of a CCTV system' (Gov.uk 2020), the number of CCTV cameras in use relative to the population density is astonishing. '[…] Politics.co.uk, [that seeks] to become the leading free-to-access digital magazine for UK politics', (Politics.co.uk 2021, Informa PLC 2022), states that 'there were approximately 5.2 million CCTV cameras in operation in the UK in 2020. This is the equivalent of one camera for every 13 people. 96% of the UK's surveillance cameras are owned by private businesses and homeowners' (2021, 2022). On the fidelity of facial recognition software, they explain that 'improvements […] will create greater scope to collect and monitor highly sensitive personal data. The growing shift from analogue to internet-connected [internet provider] systems also presents a greater risk of hacking than closed-circuit TV' (2021). Their warning extends to the […] inadequate regulation[s…] to prevent cameras from being pointed through the windows of a private property, or deliberately tracing the known path of an individual' (2021, 2022).

This technology is also used for law enforcement, widening the range of risks, as referred to in *Wirecutter*: "The facial recognition software that law enforcement agencies use [is not] currently available for public audit, and the algorithms that power the detection and identification software are often closed-box proprietary systems that researchers [cannot] investigate' (Klosowski 2020).

Similar concerns to those that permeate the prevalence of video surveillance systems within society also exist within facial recognition advancements led by Silicon Valley. A difference that sets them apart is that they have evaded the issue of fixed camera viewing points – for example, on top of traffic lights or in in shops – by dramatically reducing the size of the cameras, thereby increasing their ubiquity. These cameras are also installed in the portable devices we carry around with us wherever we go. These

[19] The UK Government's Centre for the Protection of National Infrastructure classes an OR as 'an essential tool to enable an organisation to produce a clear, considered and high level statement of their security needs based on the risks they face', (CPNI 2018, p.3).

advances have exponentially increased the scenarios in which data can be captured. These image-tracking devices have now diversified to capture data beyond our faces.

2.6 Gait Recognition

While face recognition technology is still widely in use, it has also prompted offshoots for identifying other parts of the body. Gait recognition technology, also presented as providing better levels of security, has been under development for at least two decades and is already being deployed. The imbalance between perceived benefit and real application aligns with the motivations for this research. Like the introduction of CCTV, we have been told that this new invention will improve our lives by helping to identify criminal activity, making our communities safer. This is a further example in which the rate at which a technology is being developed supersedes any regulatory system designed to maintain its ethical use.

In 2011 the UK government's Technology Strategy Board (renamed InnovateUK) jointly funded a £3.1m Viewers Situational and Spatial Awareness for Applied Risk and Reasoning (VSAR) project, completed in preparation for the 2012 Olympics (Czyzewski 2011). The National Physical Laboratory was also a partner: although it has a long history, dating back to 1900, this organisation was originally established to standardise measurements and the tools used to gauge them (National Physical Laboratory 2021). It previously functioned with a Government-Owned, Contractor Operated (GOCO) model before it was brought under the Department of Trade and Industry in 2004, followed by the Department for Business, Energy and Industrial Strategy in 2015 (formerly called the Department for Business, Innovation and Skills). In 2012 the NPL '[…] developed a walking gait recognition system that can be used to help track a person through a CCTV-monitored area by analysing the way that they walk' (Excell 2012, sub-heading). After their system '[…] record[s] a person's gait signature, the system is then able to check to see where else that person has been in [a] building and displays the results in the computer model' (2012, para. 3). Another version of gait recognition technology is an imaged-based camera tracking system that was presented at the International Symposium on Broadband Multimedia Systems and Broadcasting (Dawes, Chandaria and Thomas 2009). This variant was developed for broadcasting video footage of sport on television. It allowed the camera operators and commentators to easily track players in real time.

Experiments on the cutting edge of gait recognition technology development have also been happening in recent years. One such adaptation is an open-source tool created by software engineer Manuel Abbatemarco. Though a fully realised product has not yet come to market, the Gait Analyser and Wearable Movement Sensing Device is a low-cost version that, 'can be used to analyse gait pattern and other human movement,' (Abbatemarco 2020, title descriptor) and is aimed at healthcare providers. It is intended to look at individual pedestrian movement in patients to help physicians identify maladies like Parkinson's disease, stroke, and orthopedic issues. The relevance here lies not in its level of fidelity, but that these types of developments are ongoing and spreading across multiple sectors.

Despite the fact that these adaptations originated more than a decade ago, the development of gait recognition is still somewhat nascent in comparison to the computer vision technologies used for other forms of identification and verification, such as facial recognition, but it is advancing nonetheless. Literature regarding how and why government bodies apply this technology to their populations, or what Big Tech companies' intentions are with their advancements in these areas, is noticeably lacking. These gaps have steered this study towards raising awareness about the ethical implication of corporeal capitalisation without our consent.

2.7 Algorithms

Algorithms, in their non-digital format, can be traced back to the Babylonian period (Schönhart et al. 2003). In the light of this extended timeframe, this section will focus on more recent examples, mainly because this is when they transitioned from analogue to mechanical and on to digital methods of processing. The section will concentrate on the latter development, given the ubiquity of computers today and their importance in algorithmic advancement. To identify how algorithms fit into this project, their description is compared with that of the evolving definition of artificial intelligence.

The digital computer has been around at least since Charles Babbage, Lucasian Professor of Mathematics at the University of Cambridge, conjured up the idea during his academic tenure between 1828 and 1839 (Turing 1950, p.17). Thanks to Ada Lovelace's detailed paper, published in 1843, in which she translated and expanded the Italian scientist Luigi Menabrea's description of Babbage's 'Analytical Engine' we can begin to understand the difference between the capabilities of algorithms and contemporary versions of artificial intelligence. Lovelace wrote that Babbage's creation 'has no pretensions to *originate* anything. It can do *whatever we know how to order it* to perform' (her italics) (1950, p.25). The mathematician, computer scientist and cryptanalyst Alan Turing identified these characteristics in asking the central question, 'Can machines think?' (1950, p.13), in his seminal paper 'Computing Machinery and Intelligence'. In this widely cited publication, Turing links the nineteenth-century invention to the computers of the 1950s by refuting Lovelace's declaration in the context of modern digital computing technology. He clarifies that 'importance is often attached to the fact that modern digital computers are electrical, and that the nervous system also is electrical. Since Babbage's machine was not electrical, and since all digital computers are in a sense equivalent, we see that this use of electricity cannot be of theoretical importance' (1950, p.17).

Other key figures in these disciplines later built on Turing's paper. The term 'artificial intelligence' was formally coined during 'a two-month, ten-man study of artificial intelligence' (McCorduck 1977, p.953) in 1956, in which 'the study [was] to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it' (1977). The attendees included, among others, John McCarthy, Marvin Minsky and Nathanial Rochester, who are all frequently referenced in the history of AI. While the term was originally established over half a century ago, for the purposes of this research recent definitions are used. In the light of the

crucial relevance of the information economy, a contemporary definition is drawn from this global context. In *A Brief History of Artificial Intelligence: On the Past, Present and Future of Artificial Intelligence*, European Business School Professors Michael Haenlein and Andreas Kaplan refer to their own definition in the amusingly titled 'Siri, Siri, In My Hand: Who's the Fairest in the Land? On the Interpretations, Illustrations, and Implications of Artificial Intelligence'. They define AI as 'a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation' (Haenlein and Kaplan 2019, p.5). This aspect of flexibility, referred to later in this chapter in relation to automation (pp. 50-52), was also cited in a 1978 investigation, *Human and Computer Control of Undersea Teleoperators* (Figures 13-15, p. 51).

> Possibly the most important general principle at this early stage in the development of supervisory control for teleoperators is flexibility. As experience is gained, as new sensors and actuators are developed, the trade-off between human and computer control will shift. A properly designed supervisory control language which allows communication in a variety of levels and modes will be ready for adaptation and evolution. (Sheridan and Verplank 1978, pp.6-17)

To further express the differences between algorithms and AI, it may be helpful to revisit the digital realm. This online description details the difference in complexity that exists between the stop-executing process of a single algorithm versus the collection of algorithms with self-adjustment capabilities, defined as AI:

> An algorithm is a set of instructions — a preset, rigid, coded recipe that gets executed when it encounters a trigger. AI on the other hand — which is an extremely broad term covering a myriad of AI specializations and subsets — is a group of algorithms that can modify its algorithms and create new algorithms in response to learned inputs and data as opposed to relying solely on the inputs it was designed to recognize as triggers. This ability to change, adapt and grow based on new data, is described as "intelligence". (Krishnan and Ismail 2018).

The computer science writer Drew Robb offers a similar hierarchical perspective through the conceptual comparison of how AI builds from algorithms. He synthesises:

> Algorithms can be regarded as the essential building blocks that make up artificial intelligence. AI can use various algorithms that act in tandem to find a signal among the noise of data and find paths to solutions at levels of complexity at which humans would not be capable. AI makes use of computer algorithms to impart autonomy to the data model and emulate human cognition and understanding. (Robb 2022)

Echoing Chapter 2, in which the difference in pace between the establishment of legislation related to technological innovation is identified, other fields offer further clarity. In their paper 'International Human Rights Law as a Framework for Algorithmic Accountability', McGregor, Murray and Ng 'consider [an] algorithm as a computer agent that applies rule based or non-rule based (i.e., machine learning based) approaches to develop an output' (2019, p.315).

That algorithms have evolved significantly through history has created a rich yet increasingly complex relationship with AI. Their progressive adoption and assimilation in society seems to be giving them a life of their own. Since 1977, McCorduck's romantic view that 'Artificial intelligence comes blessed with one of the richest and most diverting histories in science because it addresses itself to something so profound

and pervasive in the human spirit' (McCorduck 1977, p.954) does not appear to have completely vanished. But more recently, opinion appears to be shifting.

2.8 Algorithms: Aversion

The literature about the notion of algorithm aversion is scarce. It has also been characterised somewhat differently in the past. Jussupow, Benbasat and Heinzl's 2020 paper 'Why are we Averse Towards Algorithms? A Comprehensive Literature Review on Algorithm Aversion' is one of the few publications that offers a background to this newer perspective on algorithms. They propose that there is a trend for human users to shy away from engaging with algorithms, despite their apparent superiority in executing certain tasks. They suggest that the reason for this tendency may be the possibility of *im*perfection in algorithms, leading to bias. A preference is identified such that 'if users have algorithm aversion they have a biased assessment of the algorithm which they do not display towards a human agent' (Jussupow et al. 2020, p.4). They support this claim by defining algorithm aversion through an explanation of the difference between relevant algorithm types:

> A performative algorithm is able to accomplish independent actions by gathering information, decide and execute, leaving the human in the role to monitor outcome and algorithm performance. An advisory algorithm, on the contrary, only provides support to the user and does not act. The final decision remains with the user. (2020, p.4)

This comparative description underlines that potential aversion within human-algorithm interaction is rooted in decision-making. This is the real crux of the issue and, complemented by the definition by Jussopow et al., identifies that degrees of agency vary between the agents operating within such a system. Maintaining a balanced view, they note that a few authors '[reveal] that decision makers have an appreciation for algorithmic support instead of algorithm aversion as they adjust more towards estimates of algorithms than towards estimates of human agents' (Jussupow et al. 2020, p.2). Humans generally consider accountability carefully during a decision-making process, and this appears to be no different when it applies to algorithms. For example, when a performative algorithm is employed, research shows that the outcome is accepted with less interrogation of the results (Jussupow et al. 2020), whereas if an advisory algorithm is used, it tends to be seen more as advice. Perhaps humans feel implicated in the possible outcomes in this scenario because they are aware of their engagement, and thus feel partly accountable. Whether this is seen as a loss of control in the process or a matter of accountability also depends on the context of the relationship, and how high the stakes are in the first place.

2.9 Algorithms: Accountability

Linked to this, and worthy of equal attention in terms of algorithm aversion, is algorithmic accountability. This is also entangled with agency in the decision-making process, but considers what actors are involved, who they are, and how the outcomes of processes employing algorithms may impact humans.

While it is unusual to cite the recent unexamined work of another PhD candidate, Maranke Wieringa's 2020 paper 'What to Account for When Accounting for Algorithms - A Systematic Literature Review on Algorithmic Accountability' demonstrates the increasing attention on this topic. The paper is one of the first to present a sufficiently referenced '…definition of algorithmic accountability based on accountability theory and algorithmic accountability literature' (Wieringa 2020, p.1), and has been both widely read and influential. It is somewhat surprising, however, that this concept had not been coined earlier, let alone properly defined. Building on past literature, the author states:

> As algorithms are increasingly applied within a rapidly expanding variety of fields and institutions affecting our society in crucial ways, new ways to discern and track bias, presuppositions, and prejudices built into, or resulting from algorithms are crucial. The assessment of algorithms in this matter has come to be known as 'algorithmic accountability' (2020, p.1).

Public awareness of algorithmic accountability has been increasing, somewhat thanks to the implementation of General Data Protection Regulation (GDPR) in Europe, but, like the recent trend towards algorithm aversion, it could also be due to collective human intuition. Human beings sometimes tend to operate in a herd-like way, requiring a few risk-taking pioneers to initiate the momentum that eventually oscillates attitudes towards a behavioural transition. This may regarded as instinctive human nature, but, deviating from the aim of accruing financial wealth, this research attempts to promote a future for the development and use of algorithms, following the viral spread of AI, to prioritise the well-being of humans, grounded in critical insight.

The shift in behaviour described here is gaining traction, following the publicising and exposing of some of its negative impacts. Among other factors, revelations of machine learning (ML) bias[20] in human profiling have helped to bring the effects of AI on society to light. ML bias can be defined as the situation in which an algorithm repeatedly generates biased results through inaccurate assumptions of the machine learning process (Larkin 2022). For example, the Correctional Offender Management Profiling for Alternative Sanctions (COMPAS) software used by judges in the United States is designed to measure the risk of recidivism in prisoners (Mehrabi et al. 2021; Angwin et al. 2016). Upon investigation it was found that its, 'facial recognition algorithm could be trained to recognize a white person more easily than a black person because this type of data has been used in training more often', resulting in high levels of false identification and prediction rates (Larkin 2022; Mehrabi et al. 2021). As a result of this situation being documented and made public, this information has raised questions about algorithms in key decision-making processes.

Such choices within such a structure relate again to the incongruent speed of deployment between legislation that has potential to apply to technology and its rate of development. This risk increases further with the significant actors in these relationships, such as Big Tech companies and their limited accountability in the face of basic international human rights law (IHRL). IHRL law is used as a context here as it is an existing framework that already possesses global outreach, presenting a starting point from

[20] Also known as algorithm, or AI, bias.

which to address the complexity of this balancing act. Incidentally, McGregor and Murray, and Ng's 2019 paper 'International Human Rights Law as a Framework for Algorithmic Accountability' was funded by the UK Economic and Social Research Council, testament to the pertinency of this subject. They investigate the social impact of algorithms in decision-making, specifically 'the risk of discrimination arising from the use of algorithms in a wide range of decisions from credit scoring to recidivism models' (McGregor et al. 2019, p.310). It is a comprehensive argument that 'IHRL might offer a viable framework as a means to address the gaps [the authors] identify in current proposals for "algorithmic accountability"' (2019, p.311). They qualify this by stating that:

> As part of a wider discussion on regulation of the AI sector, some commentators now also propose human rights as an addition or alternative to ethical principles to address some of the (potential) harm posed by the development and use of AI. However, [the] existing literature on algorithmic accountability [has] not engaged in a detailed examination of whether and how the international human rights law framework might itself offer a response to the overall risks to human rights posed by algorithms. (2019, p.312)

Although their context differs from the art as research approach of this thesis, it still involves the same system agents: humans and algorithms. They also state that 'businesses, particularly large technology companies, are central actors in this area. However, the scope and content of businesses' human rights responsibilities are still in a process of development under IHRL' (2019, p.313). Crucially, their argument includes that, 'IHRL […] only establishes "expectations" as to how businesses should operate, [but] does not currently establish direct obligations under international law' (2019, p.313). There are developments towards solving this imbalance, like the European Commission's Digital Services Act package[21] which seeks:

1. To create a safer digital space in which the fundamental rights of all users of digital services are protected; and
2. To establish a level playing field to foster innovation, growth, and competitiveness, both in the European Single Market and globally. (Directorate-General for Communications Networks, Content and Technology, first para. 2023)

This is likely to be a major blow to Big Tech companies who currently avoid regional laws despite the profit they accrue occurring across geographic borders. Critically, McGregor and Murray, and Ng's paper shows that some believe that trying to solve this issue is beyond hope – that it is too late, due to the expansiveness and pre-existing application of algorithms, but that it is essential to challenge this outlook, however bleak. They agree that '[…] space remains to address the existing and potential harm to human rights arising from the use of algorithms in decision-making' (2019, p.314). Encouragingly, their '[…] argument is that a human rights-based approach to algorithmic accountability offers an organizing framework for the design, development and deployment of algorithms, and identifies the factors that States and businesses should take into consideration in order to avoid undermining, or violating, human rights' (2019, p.313). Taking a similarly systemic stance, they warn that 'greater focus on the scope and

[21] Passed by the EU in April 2022 and published on 27 October 2022, the Digital Services Act and Digital Markets Act ('the package)' came into force 16 November 2022. It will apply across the European Union, 'fifteen months or from 1 January 2024, whichever comes later, after entry into force' (European Commission 2023, para. Next Steps).

implementation of States' obligations and the expectations placed on businesses in relation to prevention, oversight, accountability, and remedies is needed' (2019, p.314).

McGregor et al. are understandably asking for algorithmic decision-making to be addressed in the same way that human decision-making occurs. And while this could be interpreted as suggesting that algorithms are equal to humans, the parallel they have drawn is powerful, nonetheless. In essence, it respects a shared aim of increasing our collective attention towards algorithmic accountability to reveal the risks, although it lacks any connection to the possible bodily effects of AI. While this is no panacea, it does attempt to promote future solutions through documentation and performance.

2.10 Algorithms: The Body

> Expert Systems, that is, collections of rules which assume that human intelligence can be formalized and reconstructed in a top-down approach as a series of "if-then" statements. Expert Systems can perform impressively well in areas that lend themselves to such formalization. (Turing 1950, *page unknown*)

While dance has been formalised for centuries, evidenced by ballet alone with its group of globally acknowledged 'schools of technique', such as the Cecchetti, RAD (Royal Academy of Dance), Vaganova, Bournonville and Balanchine Methods, and the French School, these are relegated to codified languages used to teach, examine, and record ballet dancing. But dance, like other art forms, is not simply a set of established techniques that have evolved over the years to support the manifestation of new material. Even within classical ballet, dazzling individuality shines through, often as a result of extensive training, supporting the creation of a unique corporeal identity. Prima ballerinas are at the pinnacle of the rigid hierarchical structures in which they function and who have produced them. It would be difficult to argue that interest in dance is simply based on the technique or its formalisation. It is this technical mastery that often identifies the prima ballerina as an artist in the first place: one informs the other. Yet like dance companies, a hierarchy remains within which artistry capitalises on technical prowess. Using this outlook, it becomes easier to regard dance as particularly difficult for the expert systems of artificial intelligence to commandeer. However, computer-powered technologies are developing beyond their original intended applications all the time. Who is to say that gait recognition technology could not be adapted to process the complex movements of dance, for example? And while this may not be the software architect's present objective, it does complicate the relationship between computer vision advancements and the ease with which gait recognition technology can identify us at a distance without our knowledge. What is concerning is that these developments are viewed optimistically within academia:

> Gait recognition is an important research topic in the area of video surveillance which deals with identifying individuals from their walking patterns. Unlike other biometric recognition methods like fingerprint recognition, iris recognition, etc., gait recognition can be performed accurately even from low-resolution videos captured from a distance by surveillance cameras. (Gupta and Chattopadhyay 2021, p.76)

More scientific in approach than this artistic research, why such a statement does not raise questions around privacy and the motivation behind its uses is unclear. Why is identifying individuals perceived as a positive outcome? Do the researchers not wonder who installs these systems, and for what purposes? Furthermore, whose security are they apparently protecting from supposed risk with this covert surveillance technique? And how would the person identified maintain their rights and agency in relation to who can capture them in this way?

Surveillance is not the only anticipated use of this technology. In 'Human Gait Recognition Based on Multiple Feature Combination and Parameter Optimization Algorithms', the authors expand the context beyond that of standard bipedal locomotion,[22] speculating that 'if the experimental conditions permit, the proposed analysis method of gait recognition can also be extended to the case with walking dysfunction in the future' (Gao et al. 2021, p.12). They expand on this by stating that 'gait pattern recognition technology based on sEMG[23] signals has significant research value in the fields of intelligent prosthetic control and assisted rehabilitation' (2021, introduction para.), establishing the potential benefits for physical impairments. But if 'walking dysfunction' was rephrased as simply a differently controlled physicalisation, how is it so different from the mostly non-bipedal movements in theatre dance forms?

With the launch of Sputnik, the first artificial satellite, in 1957 (Crooks 2022) the United States Department of Defense launched their Defense Advanced Research Projects Agency (DARPA), with a commitment that 'it would be the initiator and not the victim of strategic technological surprises' (DARPA no date, para. 2). Its 'singular and enduring mission [is] to make pivotal investments in breakthrough technologies for national security' (no date, para. 1). They funded the Human Identification at a Distance project at Georgia Institute of Technology with the goal of 'developing ways to identify humans at a distance [focusing on] gait recognition' (Bobick et al. 2005, para. 1). The specific innovation identified within this project is 'a technique that recovers static body and stride parameters of subjects as they walk' (2005). The motivation for this research is unclear in relation to accepted ethical practice, although in parallel it is possible to see how it could support the contribution to well-being (for improving physical impairments) explained above. However, as their 'approach [is] an example of an *activity-specific biometric*: a method of extracting some identifying properties of an individual or of an individual's behavior that is only applicable when a person is performing that specific action' (2005), this still raises suspicions about where else this research might apply. That this is supported by military funding, theoretically in the name of 'national security', only serves to confirm this alarm.

Perceived benefits and pitfalls are commonplace in innovation, technological or otherwise. These particular developments, with their ambiguous roots, support the rationale for focusing on the potential physical effects of AI on our living bodies. Digital computer applications that can mirror motion capture capabilities on a larger scale while operating with nearly invisible apparatus does raise concerns. The fact

[22] The movement of animals (ostriches for example) and humans on two legs while in an upright position.
[23] 'The surface electromyography (sEMG) signal is a complex interference pattern of the electrical activity during the muscle contraction. It is closely related to muscle activity and exercise status' (Wu et al. 2019, p.1).

that the knowledge (and therefore use) of this, and thus its increasing deployment, is currently focused on security, surveillance technology, intelligence and defence reveals opportunities within artistic and academic spheres. These possibilities multiply with the recent leaps in the development of AI through machine learning, big data, neural networks, and deep learning inventions. Nick Bostrom and Eliezer Yudkowsky agree: '[…] it will become increasingly important to develop AI algorithms that are not just powerful and scalable, but also *transparent to inspection* – to name one of many socially important properties' (2014, p.1). This coincides with a growing need for a deeper understanding of the powers and risks of the pervasiveness of AI, a gap this research seeks to address.

2.11 AI: Overview

An aim of this research is to look at how AI may affect choreography, so it is therefore important to establish the meaning of AI in this context. This is mainly because confusion can arise in the differences between the definitions of algorithms, machine learning (ML) and AI in contemporary discourse. Part of the reason for this is their underlying connectivity, although these elements may also be considered separately, and their importance to this investigation warrants a chapter to itself. To relate these topics to this research, they are discussed in a historical context in this section.

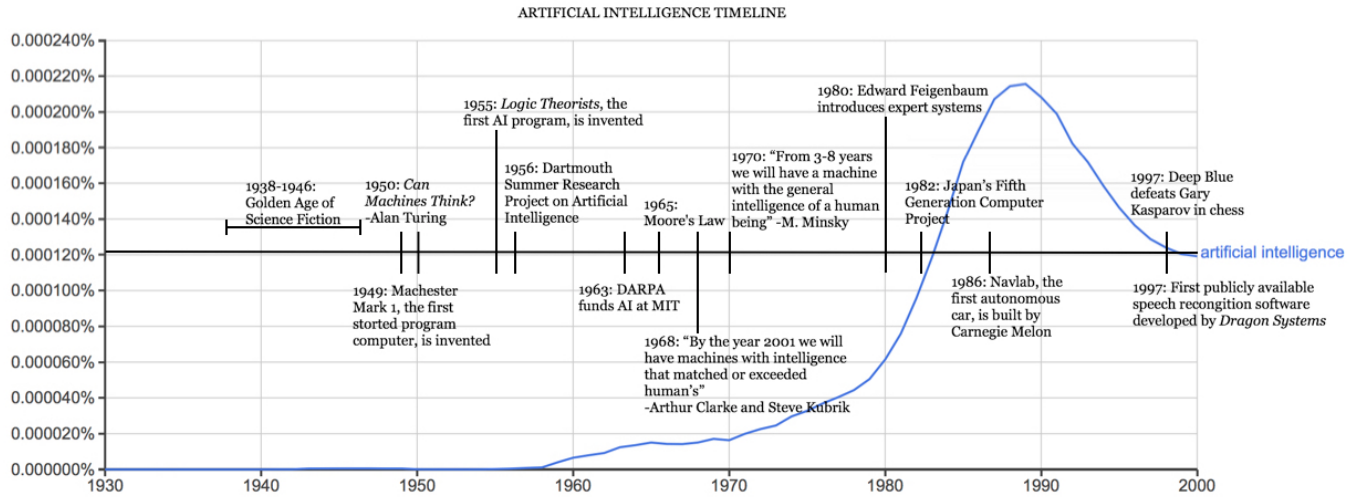
In present-day discourse 'artificial intelligence' is often used as a blanket term to describe forms of 'machine thinking' (Johnson-Laird 1993, Bonnefon and Rahwan 2020), yet its actual meaning is more nebulous, stemming from the sheer magnitude of the topic. Broadly speaking, AI can span 'from machines truly capable of thinking to search algorithms used to play board games' (Smith et al. 2006, p.4). The concept of an inanimate entity possessing similar traits to human (or human-like) intelligence has a long history. This section covers some of the main aspects of AI, including fears about its prevalence, its capability for automation, our trust in its use, the ethical implications of AI, and what the near future of AI might look like, examined from a historical context. The period between 1930 and 2000 was particularly significant, so this timeline has been included to plot the key milestones through the contemporary perspective discussed in this section.

2.12 AI: Fear + Trust

> It seems probable that once the machine thinking method has started, it would not take long to outstrip our feeble powers. ...At some stage therefore we should have to expect the machines to take control (Turing, quoted in the 2022 State of AI Report, p.95)

Turing's prediction does not seem as far-fetched today as it did in 1951. As with most new inventions, societal scepticism often varies in direct correlation with the perceived degree of change beyond the status quo. Just as technology has been designed to improve daily life, inverse impacts should also be a consideration. As outlined in this chapter, artificial intelligence is not new, but its recent widening application and increasing competency has produced echoes of Turing's thoughts. A catalyst for distrust is the feeling of being threatened. Therefore, if a threat generates fear it is reasonable to instinctively regard the threat with fear. Taking a reductionist approach, the actuator in the context of algorithms and AI is that the latter has the capacity to 'learn' from its actions and make adaptations. If the AI system engineers themselves do not have absolute transparency in how they do this, how can the general public be expected to understand them? It is this mystique that helps to produce a fear and distrust of AI.

Table 1: Artificial intelligence timeline 1930-2000 (Anyoha 2017).



Considering its significant impact on how we have thought about machines and our relationship to them over the last three-quarters of a century, it might be best to begin with the questions Alan Turing originally posed, discussed and addressed in his 1950 paper 'Computing Machinery and Intelligence'. It would be negligent to bypass this seminal publication, considering its astounding impact on modern thinking about computers and how humans engage with them. This thesis is, of course, not being compared to Turing's authorship or research, but seeks to build on his groundbreaking publication through a contemporary lens. Turing created the now infamous Imitation Game (or Turing Test: see Figure 11), as a means of addressing his paper's initial question: can machines think? The Turing Test is still considered today as a benchmark to identify the intelligence of an artificial system: if a human (C) is interacting with another human (B) and a machine (A) and is unable to distinguish the machine (A) from the human (B), then the machine is said to be intelligent (Haenlein and Kaplan 2019). Turing's questions and methods foreground current issues: for example, the impact of recent artificial intelligence adaptations on corporeal identities, which this research explores through a novel choreographic method co-developed with dancers.

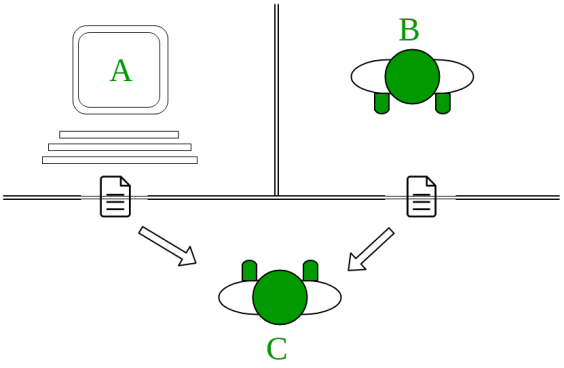


Figure 11: Turing test diagram (GeeksforGeeks 2022).

While he does not describe it as such, Turing distinguishes the potential of the ambiguity of learning machines from that of the other forms he identifies, such as digital computers – discrete state and abstract, among others. He explains: 'an important feature of a learning machine is that its teacher will often be very largely ignorant of quite what is going on inside, although he may still be able to some extent to predict his pupil's behavior' (Turing 1950, p.32), essentially describing a 'black box'[24] phenomenon. It is plausible that Turing's demonstration of opacity in his 1950 version of a learning machine could produce feelings of distrust or fear in the observer. Conversely, if a human student is learning, it can be said they are also thinking. So would they then trust a teacher's statement without question, or would they ask how the teacher came to be so sure of it? And if the teacher refused, or was unable, to provide that explanation, would the student distrust the statement or those that came after it? Similarly, would the people involved in a similar situation in which an 'intelligent' computer provides the responses have similar issues of trust, as they do not actually know how the computer arrived at the result? This difficulty in understanding is a conundrum that has persisted over the years.

Although the term 'artificial intelligence' was not coined at the time, sixty-five years later the unknown territory of the black box reality still exists in our contemporary version. Following on from Turing's suggestion that 'we may hope that machines will eventually compete with men in all purely intellectual fields', he proposes that 'the playing of chess would be best' (1950, p.32). This perhaps optimistic challenge was eventually addressed in 1997 with IBM's Deep Blue chess-playing programme that 'was able to beat the world [chess] champion Garry Kasparov' (Haenlein and Kaplan 2019, p.8). Turing's positivist spin prevailed when, in 2015, Google sought to raise the stakes by using the more complex game of Go, with its 361 potential opening moves, compared to chess's 20 (2019), with their adaptation of artificial neural networks 'in the form of Deep Learning [with] AlphaGo [that] was able to beat the world champion' (2019). To elucidate this within the contemporary context, in his article 'AI vs. Algorithms' Robb explains that 'algorithms, too, are the backbone of machine and deep learning. It is the algorithm that is the substitute for the human processing the information' (Robb 2022). Neural networks are not a new concept, but research in this area 'stagnated in 1969 when Marvin Minsky and Seymour Papert showed that computers did not have sufficient processing power to handle the work required by such artificial neural networks' (Haenlein and Kaplan 2019, p.8). Alongside AlphaGo, Google released the open-source software library TensorFlow, which 'is a framework with codes for many deep learning models, so machine learning developers and engineers can easily implement these building blocks on their own deep learning models and as a basis for more advanced research' (Lee 2018). Fuelled by technology giants like Apple, Samsung and Qualcomm, who '[…] are also actively participating to create and foster open-source communities' (2018), the current view is that 'open source is believed to be the rocket fuel for innovation in the entire software industry' (2018). The catalyst for this is collective societal mistrust, often producing a sense of fear, which can be linked to 'Google […] registering key patents to claim ownership over AI techniques, in particular related to deep learning' thereby generating 'a concern for many in the open-

[24] In this scenario, a computing device produces something of use, but does not reveal how it achieved this result. The inner workings are opaque, or 'black'.

source community' (2018). But these developments do not seem to be languishing. Instead, the re-injection of 'artificial neural networks and Deep Learning [now] form the basis of most applications we know under the label of AI' (Haenlein and Kaplan 2019, p.8).

Part of the reason that the resurgence of neural networks that employ machine learning has been receiving attention lately is linked to Turing's teacher-student analogy. This concern around ambiguity in their function has been exacerbated by cases where this form of AI has made decisions with unwanted results, and the human interpreter is unable (or unwilling) to elicit the rationale, thereby causing frustration and roadblocking solutions. Thankfully, there have been efforts to understand these challenges and publicise their difficulties. Using a case of refused mortgage applications, Bostrom and Yudkowsky contrast machine learning models for transparency in such decisions. They explain that '[…] if the machine learning algorithm is based on a complicated neural network, […] then it may prove nearly impossible to understand why, or even how, the algorithm is judging applicants based on their race' (2014, p.317). They suggest that 'a machine learner based on decision trees or Bayesian networks is much more transparent to programmer inspection (Hastie, Tibshirani, and Friedman 2001 via Wilshaw 2018), which may enable an auditor to discover that the AI algorithm uses the address information of applicants who were born or previously resided in predominantly poverty-stricken areas' (Bostrom and Yudkowsky 2014, p.317). Irrespective of the direct or indirect use of AI, it becomes easier to understand how these recent leaps in AI development could damage user trust, and are also likely to increase users' fear of them.

Another factor contributing to the fear of AI is a societal concern that livelihoods will be increasingly automated, eventually rendering the raison d'être for professional skills obsolete. This raises questions about the basic human need to have purpose in life. The public's general confusion about AI is contextually understandable, given that even the specialist engineers expanding its reach do not have an absolute comprehension of its inner workings. A transfer of agency becomes possible when a perceived threat to human dominance in the workplace stems from a power shift within decision-making processes:

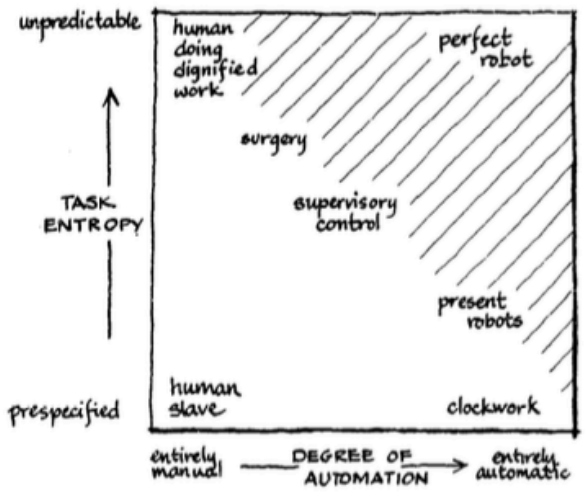


Figure 12: Task entropy - control autonomy of machine, (1978, pp.4-11).

> The interaction and interdependence of algorithms, including artificial intelligence (AI) or machine-learning algorithms, and big data have enabled their deployment in many key areas of decision-making, such that many functions traditionally carried out by humans have become increasingly automated. (McGregor et al. 2019, p.310)

The inclusion of the deployment of deep learning and neural networks has supported an increase in these feelings. Turing again helps to contextualise the motivation for an aversion to algorithms and AI, saying: 'we like to believe that Man is in some subtle way superior to the rest of creation' (Turing 1950, p.21). And while his summary links the theological critique of his catalyst question 'can machines think?', he concisely

captures the fear of considering this question by qualifying that 'it is best if [man] can be shown to be necessarily superior, for then there is no danger of him losing his commanding position' (1950). Again, this fear of automation can be tied to the notion of human agency in these new system formats and the opacity in their functionality.

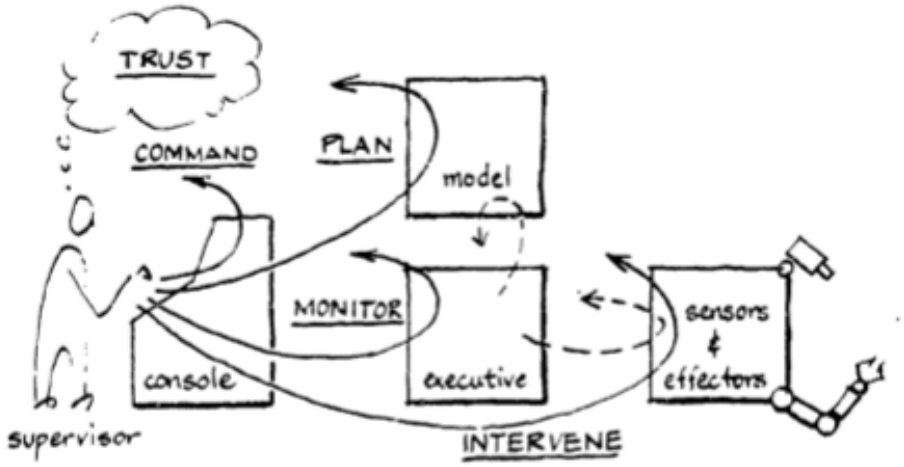


Figure 13: Roles of supervisor (1978).

Consequently, the penetration of automation into human control has been discussed for some time. Although looking to military references may raise some ethical questions, Sheridan and Verplank's paper 'Human and Computer Control of Undersea Teleoperators', funded by the US Navy, comes from an academic context, providing a human-focused perspective, despite the fact that it was published over 40 years ago. Originating from the authors' research at the Man-Machine Systems Laboratory at the MIT Department of Mechanical Engineering, the publication contains diagrams to support their investigation into a relationship study similar to this thesis. They consider the assumptions that the risk to human life would decrease while operating heavy machinery underwater if levels of automation increased. They sketch out (Figure 12) automation against entropy[25] through variables ranging from a human (user) doing dignified work and clockwork, and the extremes of a human slave versus a perfect robot.

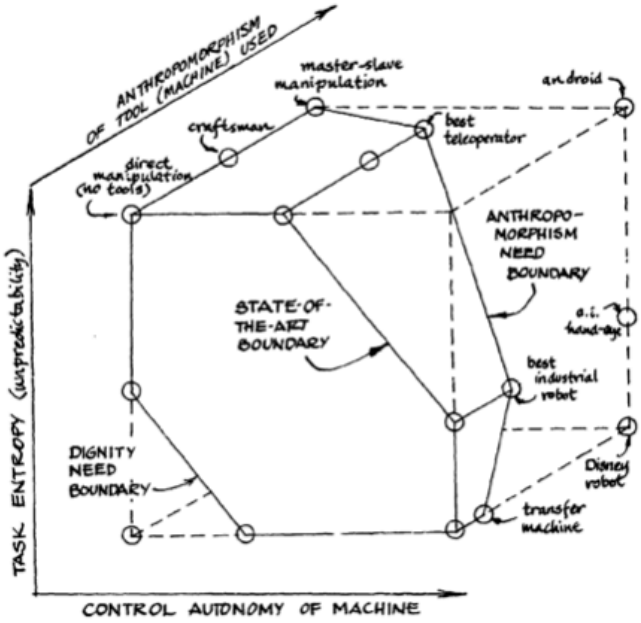


Figure 14: Less anthropomorphism as control autonomy increases (1978).

Advisory algorithms come up again in the author's schematic diagram of the role of a supervisor during a proposed semi-automated machine operation, illustrating that user trust issues within automation are not new (Figure 13). The authors expand on their choice of extremes already laid out in their previous diagram, stating their 'refusal to employ humans as slaves [relative to] our limits on knowledge' (1978, p.5-25), and explain that the 'right-rear diagonal slice which, for good design, requires less anthropomorphism as control autonomy increases or as the task entropy decreases (task becomes more predictable)' (see Figure 14, 1978). Whether people are still concerned about this type of enslavement today is debatable, but this anxiety apparently continued for at

[25] Entropy is the extent to which a system is random.

least 27 years after Turing's original speculation. Even if this teleoperator study was more about the mechanical connection within a human-technology relationship, that such enquiries were already questioning effects on our physical being is testament to the topic's importance.

As mentioned earlier, with the changing times comes new terminology. Where it may have then been classed as a risk of enslavement, today the 'interaction of workers with ever-smarter technological devices and robots also risks introducing new elements of dehumanization' (De Stefano 2018, p.8). Irrespective of any change in wording, the potential for danger is directly related to 'the growing relevance of so-called collaborative robots or co-bots, namely [those] that physically interact with human users, within a shared workspace, and by the advances in the development of autonomous AI tools and machine-learning technologies that, […] increasingly allow eliminating or minimizing the role of human supervisors in managing the workforce' (2018, p.8). It therefore appears somewhat regressive to try to better understand how humans can safely integrate into increasingly automated environments by using a codified system of classification. Building on Sheridan and Verplank's paper (and others), more recent versions (see Table 2) have not materially changed. Drawing from the variation in advisory and performative algorithms, they still map degrees of computer automation on a scale relative to human-made decisions. With these developments, it is therefore less surprising to see an increasing datafication of everyday life.

Table 2: Levels of automation of decision and action selection (Parasuraman et al. 2000, p. 287).

HIGH	10. The computer decides everything, acts autonomously, ignoring the human.
	9. informs the human only if it, the computer, decides to
	8. informs the human only if asked, or
	7. executes automatically, then necessarily informs the human, and
	6. allows the human a restricted time to veto before automatic execution, or
	5. executes that suggestion if the human approves, or
	4. suggests one alternative
	3. narrows the selection down to a few, or
	2. The computer offers a complete set of decision/action alternatives, or
LOW	1. The computer offers no assistance: human must take all decisions and actions.

These questions of automation in the face of the increasing deployment of AI are embedded in the issue of its trust. AI researcher Mark Ryan has published widely on the impacts of AI on society. In his paper 'In AI We Trust: Ethics, Artificial Intelligence, and Reliability', he distinguishes trustworthiness from reliability. He argues that 'trust is one of the most important and defining activities in human relationships' (Ryan 2020, p.2), and without this basic ingredient it is difficult to fathom how homo sapiens can function within their self-constructed social networks. This requirement is no different in relation to non-human agents such as AI. He qualifies this innately human predilection by explaining the difficulty in assessing the degree to which AI is characterised by 'the tendency for people to anthropomorphise it' (2020, p.1), perhaps because it is social connection that is truthfully being sought. When socialising, humans seek connections with other humans on some level. It therefore stands to reason that enshrining those connections – unconsciously or otherwise – that behave similarly is a natural inclination. However, the interesting crux of Ryan's paper is its rejection of 'the position taken by the HLEG [European Commission's High-level Expert Group on AI], and many within the academic field, that AI technology is something that has the capacity to

be trusted, thus undermining the fact that it can be trustworthy' (2020, p.2). His statement contradicts the view that users should increase their trust in AI, because of a misinterpretation of its basic qualities. He underscores this by saying: 'While AI meets all of the requirements of the rational account of trust, this is not a type of trust at all, but is instead, a form of reliance' (2020). Precision in definition, understanding and communication is therefore crucial for developing truly symbiotic ways of collaborating with AI.

2.13 AI: Ethics

With the increase in the rate at which technologies that can physically affect our bodies is developing, it is imperative to consider the ethical implications of this new territory. The ethics of human-to-human interaction is a known discipline, but what happens when intelligent digital agents become involved, let alone those that can 'think', to return to Alan Turing's original question? In his deliberation over the fundamental accuracy of this starting point he discusses some valid critiques, one of which is the theological objection. He declares that 'thinking is a function of man's immortal soul. God has given an immortal soul to every man and woman, but not to any other animal or to machines. Hence no animal or machine can think', followed by a fervent '[…] I am unable to accept any part of this' (Turing 1950, p.20). From this, the discussion of ethics in AI has developed in recent research as well. On this point Bostrom and Yudkowsky clarify that '[…] it is widely agreed that current AI systems have no moral status' (2014, p.322), with further discussion suggesting that we 'contemplate the possibility that some future AI systems might be candidates for having moral status' (2014, p.321). But, while '[humans] also have moral reasons to treat [machines] in certain ways, and to refrain from treating them in certain other ways' (2014), this relatively sweeping proposition may overlap with the religious connotations touched upon by Turing above. However relevant this aspect might be, this research is focused on the impacts of AI on society as an entity without specifying those with ideological beliefs associated with their faith.[26] This is for the same reason that Turing asserted all those years ago that we '[…] should find the argument more convincing if animals were classed with men, for there is a greater difference […] between the typical animate and the inanimate than there is between man and the other animals' (1950, p.20). Drawing from his perennially relevant statement, this research seeks to raise questions about our future relationship with AI, thereby indirectly considering the ethical standards required to preserve our physical, emotional, and mental well-being.

Such varied impacts also make it challenging to separate ethical concerns from moral ones. Although this is a moving target brought forth by the rapid developments in AI technology, there are two criteria generally connected to the moral status of an entity: sentience and sapience (Bostrom and Yudkowsky 2014, p.322). Ray Kurzweil suggests that the former is related to consciousness, explaining that 'It's hard to say that a fertilized egg is conscious or that a full-term fetus is not' (Kurzweil 1999, p.50), in the context

[26] Looking at selected demographics such as different religious groups could be the subject of future study.

of human brain development from conception. Of course, he is referring to a debate which has taken place from the turn of the last century (abortion), but his point is about questions that are difficult to define. He concludes that '[…] the contention concerns sentience. In other words, when do we have a conscious [machine] entity?' (1999). In discourse about the advancement of AI, sapience often comes into the conversation about what Vinge called 'The Singularity' (1993, p.1) in that it refers to high levels of intelligence and the capacity of being self-aware. Determining the point at which artificial or machine intelligences will surpass our own, however, is contextual to this research but does not directly connect to its central arguments. Among the related literature, Bostrom and Yudkowsky build on these two moral assessment criteria and propose a Principle of Substrate[27] Non-Discrimination, stating that '[…] if two beings have the same functionality and the same conscious experience, and differ only in the substrate of their implementation, then they have the same moral status' (Bostrom and Yudkowsky 2014, p.323). Connected to Turing's preference for the animate versus the inanimate, they clarify that 'it makes no moral difference whether a being is made of silicon or carbon, or whether its brain uses semi-conductors or neurotransmitters' (2014, p.323). This links back to the research questions enquiring about the effects of AI on choreography, if this dynamic were to be translated through the lens of the design of choreographic systems. If a biologically human dancer were to be replaced by an AI-driven non-human robot, would the robot have the same experience as the dancer?

2.14 AI: the Future

The plentitude and contemporary nature of the references cited in this chapter provide a window on how quickly algorithms and AI are advancing. As discussed in Chapter 2, these technologies are developing so fast that it becomes impossible to include those at the very cutting edge, because they would be out of date as soon as this thesis is published. Instead, artificial general intelligence (AGI) is presented, due to its significance and imminent permutation. The term has been around for a few years, but discussions beyond the inner circles of Big Tech and academia have been limited. Bostrom and Yudkowsky locate AGI within AI by beginning with their classification of '[…] current AI algorithms [as having] human-equivalent or superior performance [that] are characterized by a deliberately programmed competence only in a single, restricted domain' (2014, p.3). They then relate this via analogies: 'Deep Blue became the world champion at chess, but it cannot even play checkers, let alone drive a car or make a scientific discovery' (2014). Based on this, they warn that '[…] it is a qualitatively different class of problem to handle an AGI operating across many novel contexts that cannot be predicted in advance' (2014). In line with the authors' specific interest in AI ethics, they speculate that there are three fundamental differences that should be acknowledged within AGI:

1. The local, specific behavior of the AI may not be predictable apart from its safety, even if the programmers do everything right;

[27] An underlying substance or layer.

2. Verifying the safety of the system becomes a greater challenge because we must verify what the system is trying to do, rather than being able to verify the system's safe behavior in all operating contexts;
3. Ethical cognition itself must be taken as a subject matter of engineering. (2014, p.5).

Whether these guiding principles will be formally incorporated remains to be seen. But there are some new enterprises that appear to have similar ethical values, focusing on what has been called 'AGI alignment'. One such enterprise is the start-up Conjecture, which 'operates under the assumption that AGI will be developed in the next five years, and on the current trajectory will be misaligned with human values and consequently catastrophic for our species' (Benaich and Hogarth 2022, p.106). There appears to be hope, but its materialisation for the good of humanity remains uncertain.

Although the timing of the completion date of a doctoral thesis and digital technology advancements within AI differ vastly, academia and industry generally appear to agree that the degree of development has been exponentially greater over the last few years. It is therefore important to highlight some of perhaps the most significant publications that are current at the time of writing.

A simple Google Scholar search into the history of ChatGPT[28] itself lists two publications, showing the program's limited presence in the literature. But upon further inspection it becomes evident that 'The Future of Metaverse[29] in the Virtual Era and Physical World: Analysis and Applications' is co-authored by ChatGPT itself with three human authors (Askr, Darwish, Hassanien and ChatGPT 2023). The *MIT Technology Review* calls ChatGPT a 'cultural phenomenon' (Heaven 2023, sub-heading), but the most vocal about the deployment of ChatGPT in contemporary society appear to be those in academia and law (amongst other fields). This is probably because of its ability to produce written compositions from a series of user prompts within seconds. Built by OpenAI,[30] the AI chatbot has been gaining attention rapidly, not only due to its abilities, but because of the risks it poses to authorship and increased plagiarism.. Incidentally, the second paper is titled 'A Conversation on Artificial Intelligence, Chatbots, and Plagiarism in Higher Education', and ChatGPT is credited as an author, responding to prompts by Michael R. King. The human prompter asks about the history of ChatGPT, its origin and purpose, the risks it poses to students regarding plagiarism, post-secondary education, and other issues. Interestingly, when King asks ChatGPT how '[…] college professors could design assignments to minimise potential cheating via ChatGPT' (King and ChatGPT 2023, p.2) the programme suggests using it again to mitigate this risk. In other words, ChatGPT encourages further engagement with its potentially unethical behaviour to reduce the potential for this very behaviour in university students. This raises questions about the data the program's AI was trained on, and the bias incorporated during this process, which has ultimately

[28] The 'GPT' stands for generative pre-training transformer, which is a type of artificial intelligence.
[29] This paper defines the Metaverse as follows: 'When the actual and the virtual worlds collide, as they do in Augmented and Virtual Reality (AR and VR), the resulting technology is known as Mixed Reality (MR), a subset of VR-related technologies' (Askr et al. 2023, abstract). Two years earlier and in more plain terms, *Wired* magazine defined it as '[…] The technologies that […] can include virtual reality – characterized by persistent virtual worlds that continue to exist even when you [are] not playing – as well as augmented reality that combines aspects of the digital and physical worlds. However, it does [not] require that those spaces be exclusively accessed via VR or AR' (Ravenscraft 2021).
[30] OpenAI is an American non-profit AI research laboratory with the tagline 'Creating safe AGI that benefits all of humanity'. (OpenAI website 2023).

promoted increased user engagement for corporate gain. However, King's next prompt, asking ChatGPT to address the notion that these types of AI technologies need further investigation in relation to potential misuse, results in a degree of criticality. It suggests that considerations '[…] may involve implementing strict policies and regulations, as well as educating individuals on the importance of ethical behavior when using these technologies' (2023). Perhaps somewhat heartening to some, it may also be concerning to others because of the nascent critical thinking ability, a skill often relegated to at least postgraduate education. But categorising this claim as a truth remains to be seen.

Dall·E, also created by OpenAI, generates visualisations rather than text, but operates in a similar fashion, whereby users prompt it with written descriptions. The programme's aim seems to be to produce realistic representations, and newer editions have already been released beyond its beta version (OpenAI 2022).

These recent AI developments have started to reveal their possible impacts on creative processes, although to what precise extent remains to be seen. If they can generate representations of text and images that appear to be by humans, and increase user engagement, then the jump to human movement – dance choreography or otherwise – may not be all that far off. How the tangible sensation of AI might manifest is not yet comprehensively understood. But the importance of increasing this understanding, for humanity's sake, is evident, if for no other reason than our bodily safety. The anticipation of the contextual shift to corporeal impact, whereby AI may be able to physically touch us, constitutes the main motivation of this research.

2.16 Corpo-veillance

To summarise the breadth of this chapter it may be most helpful to dissect a key portion of the thesis title: *Corpoveillance*. This is a new concept and term[31] that came through the research practice and writing processes. 'Corpo-' as in corporeal, relating to a person's body, and '-veillance' referring to surveillance: a portmanteau term to denote the scrutiny, examination, tracking, and/or supervision of the bodies of human beings actively existing, moving and interacting in any given context, including virtual, augmented, and mixed realities, and with the potential intention of control.

The creation of this new term embodies the importance of interrogating the application of gait recognition technology from artistic perspectives. This context is opportune because its academic grounding is rooted in the preservation of individual freedoms, retaining ownership of corporeal identities and control over their destinies, instead of generating financial income. The same arguments about data collection for the benefit of the supercomputer owners is equally relevant in this scenario. The differences here are the controlling forces and the fundamental motivations for the decision-making processes. Equalising such power imbalances through the redistribution of the value of human-generated data could serve to unveil the deception around these technological advancements.

[31] At the time of completion this term was not found to exist in this guise or in relation to any form of technology, art or research.

This research has sought to devise a method that preserves human presence within a scenario in which AI is able to make physical contact with our bodies. By studying the uniqueness and technical power of dance and dance artists (also described in the next chapter) and their relation to these technologies, the data harvesting systems already in place built for corporate gain, the tactics used to increase these capabilities, and some of the devices that could be employed in these advancements, this chapter has located a gap in which an original system design can be situated. Interfaces that make the leap from the digital to physical worlds are already in existence, as the chapter has outlined. However, a remote communication system developed through dance choreography, demonstrating the potential effects of AI reaching out and touching us presents a conundrum that is certainly worthy of critical reflection. The individuality inherent in dancing, embodied by dancers, that moves beyond standard pedestrian bipedal activity in equally complex patterns may very well be our best weapon against our datafication, and the ensuing infringement on agency.

3 ARTISTIC CONTEXT

3.1 Embodiment

The previous chapter considered and addressed technology developments, including those affected by algorithms and AI, in the contexts of legislation, politics, and socio-economics. Using that backdrop, this chapter first looks back at figures in computing and dance, choreographic systems, and wearables (or body-tech), before moving on to discuss some key contemporary artists who are also operating in areas looking at relationships between digital technologies and AI, and our physical bodies in the real world, before concluding with an account of what was derived from this exercise in contextualisation.

Given the focus in this research on an artistic context continually led by dance, coupled with its placing of the body at the centre of inquiry, I introduce this chapter through the notion of embodiment relative to dance and digital technologies, as both my research and that of those cited herein are affected by '…being in the body,' (Baker 2010, p.13) to varying extents. However, in respect of the breadth of artistically driven work included below, it is important to outline what embodiment means for me, as a way of connecting to the work of others.

Reflecting on how I view embodiment in my own practice I find myself echoing dance scholar Hetty Blades when she was asked to define the term for herself. During an interview she replied with a description that has stayed with me, as sometimes the simplest versions are the most appropriate. Blades responded with:

> […] I keep coming back to this thing about attention and is embodiment a way of describing paying attention to the body, and I think in lots of contexts it means something a bit more complicated than that, but […] I wonder whether the idea of paying attention in really kind of simple terms provides a way into […] starting to think about the phenomenon in a […] different way. (Burrows and Hayward-Smith 2021, interviewing Hetty Blades).

Like the systemic philosophy (see 1.6 on page 26) that has emerged through my years of fashion industry experience, and which is now the natural way I interact with the real and virtual worlds around me, this notion of intentionally paying attention to my body has also become automatic from my lived experience of dance. I do not have to consciously turn these switches on in my brain and body: they are omnipresent, allowing my own version of understanding through the body. While for this thesis I have endeavoured to increase its accessibility through straightforward language, some more complexly phrased explanations that retain my intention do arise. Embodiment can also be described as '[…] immersion in the body – one's own body – in order to perceive oneself in depth. This process allows movement artists (dancers and other performing artists) to access involuntary or habitually unconscious sources of their movement and performative behaviours and to change the imaginary forms associated with them,' (Chonière et al. 2020, p.3). Irrespective of the wording used in these examples, embodiment in relation to dance and dancers (former or active) means possessing a living awareness of our bodies in any given scenario. While I agree there is some argument that this sensation could be reduced or even lost with dance in the digital

realm, this research does not specifically look in that direction. I have certainly employed digital technology in the choreographic system I have built, and sought to understand dancers' experiences of having externally provided vibrations affecting their improvisations; however, establishing a new or other understanding of what embodiment specifically means for us (and this research) is not the aim. It is instead the dynamics of agency in a human-machine-human relationship within the artistic context of choreography.

3.2 Computing and Dance

By 'machine', mentioned above, I am more generally referring to digital technologies – those that are facilitated by computers, which are in turn affecting the computerisation of dance. To help unpick this genre, I consider it from a historical perspective, building on the other systems outlined in the previous chapter.

Relationships between computers and dance have existed for almost a century, and dance has been recorded in cave drawings as far back as approximately 9000 BC,[32] which contrasts with the considerably shorter lifespan of computers. Although you could perhaps argue that the abacus was the first computer, versions resembling today's computers were invented in the first half of the nineteenth century by British mathematician Charles Babbage (Harris 2019). Incidentally, there are several key figures who have contributed to these intertwined histories over the last fifty years, and I have included them based on their specialisms and publications.

Computer scientist and educator George Politis compiled *Computers and Dance: a Bibliography* in 1990: this includes 107 bibliographic references to the topic published from 1967 to 1988, including some of his own work. Discussing the future of this version of human-computer interaction (HCI), he predicted that 'The foreseeable future is likely to include only small-scale marketable applications, particularly on microcomputers' (Politis 1990, p.87). He suggested that development in this area has been slow due to the artistic nature of dance, a lack of research funding, HCIs not being sufficiently advanced and the considerable complexity of human movement (1990). I would extend his proposition by classifying this apparent sluggishness, coupled with the difficulty in capturing human movement accurately, as a reason why dance may help rebel against body-targeting digital technology (a form of HCI) advancements. Incidentally, in 1969 the Mansfield Agreement was signed, which dictated that no research in the United States would be funded unless it had military applications (Glanville 2013, p.48). This shift away from artistic, speculative areas of research is echoed in the first generation of cybernetics established by Norbert Wiener's 1948 book *Cybernetics*, which was 'grounded in physics and mathematics and is challenging even for a mathematician. Consequently, its readers saw cybernetics as technical and engineering based' (2013, p. 46), which arguably fits with the Agreement's military aims twenty years later.

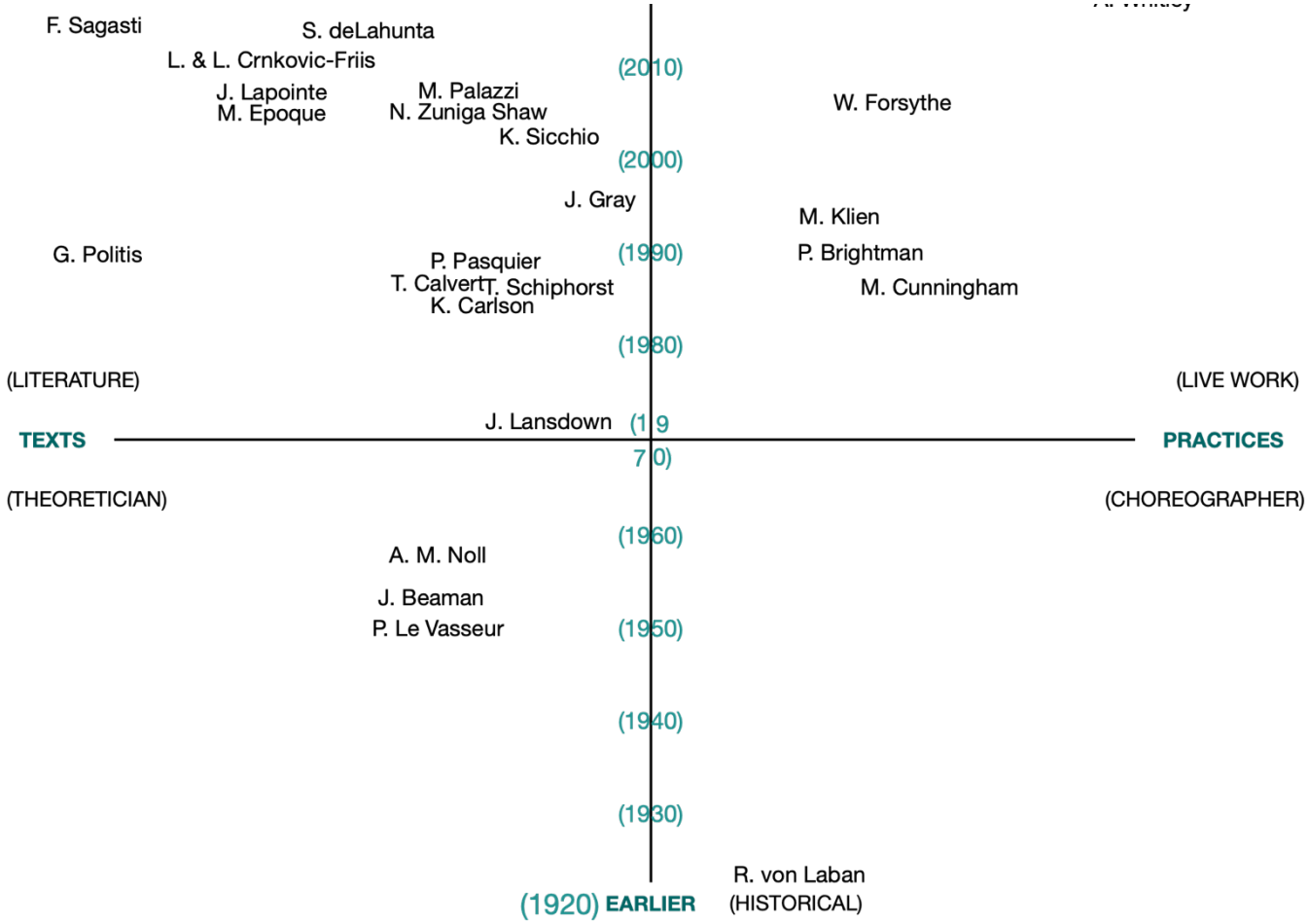
[32] In what is now India.

With a different perspective, Dr. Judith Gray is an American dance researcher, teacher and author who has been writing and speaking on future developments in dance since the 1980s (Gray 1988). In 1989 she edited *Dance Technology: Current Applications and Future Trends* (Gray 1989) which introduced the then emerging field of dance technology, pioneered by a group of dancer-researchers in the United States, Canada, and Australia. The work of several of these feature in Politis' bibliographic summary, including Gray, Mary Brennan, Norman Badler, Thomas Calvert, and Rhonda Ryman, along with publications by Politis himself (Gray 1990). Although not an exhaustive list within the field of dance and computers (and sub-topic of dance technology), this does illustrate the breadth of research that took place, despite the resistance to it mentioned above.

More recently, in his 2019 review essay 'Information Technology and the Arts: The Evolution of Computer Choreography during the Last Half Century' (Sagasti 2019), Francisco Sagasti systematically documents the work of some of the figures who have been investigating the intersection of emerging technology and choreography. He also references Politis' predictions but expands on them, suggesting that 'later developments would provide dancers with a wider variety of computer tools and electronic devices that expanded the field in unforeseen directions' (Sagasti 2019, p.21), when referring to the previously anticipated limitations. In his paper, Sagasti includes a chart entitled 'Fifty Years of Interactions Between Information Technologies and Choreography' (see Appendix VIII, p.169). The chart is broken down into interaction types and maps the relevant work historically, from the early stages of research through to the early twenty-first century. Like many art forms, dance has multiple facets through its study, creation, documentation, and applications. As such, the contributors in Sagasti's chart are from equally diverse perspectives themselves, unified by the discipline itself. Some are choreographers (for example Peggy Brightman, Kate Sicchio and Johannes Birringer) who have also moved into writing and research, while others are scientists or technologists who have applied their backgrounds to the theory of human movement as art (such as Michael A. Noll and John Lansdown).

My research does not claim to present the first choreographic system to employ digital technology. I do, however, build upon the existing knowledge of dance technology and its application to choreography (see the chart 'Computer-aided Choreographic Systems' included as Appendix IX on page 170). A lens has been applied in the manner exemplified by the architect and educator Dr. Ranulph Glanville, as explained in his

Table 3: Dance technology players over the last 100 years (Guérin-Garnett 2022).



chapter 'Cybernetics: Thinking Through the Technology' (Glanville 2013) in Darrell Arnold's book *Traditions of Systems Theory* (Arnold 2014). Glanville refers to the educational philosopher Jean Piaget's use of the terms 'action (practice)' and 'understanding (theory)' (Glanville 2013, p.50), which offer an explanation of the balance between the two ends of the spectrum in this context. Like architecture, dance can also span these concepts, and choreography may be viewed as a system, as it is in this research. The theory and practice within choreographic research, particularly when integrating technology, are cyclical and complementary, and so this cybernetic framework has been used to plot the key figures in Table 3. Glanville outlines this circularity by stating: 'We can enter the circle of practice/theory (acting/understanding) from either concept, inevitably proceeding to the other and then back to the concept through which we entered' (2013, p.7). It is important to note that while I have indicated each actor only once, nearly all have been active in their respective practices and studies over several years, often decades. I selected one of their key works that linked to the core themes of this research, but nearly all of them function across multiple aspects within their careers spanning choreography, notation, research, technological application, creative production or otherwise. For example, William Forsythe is often known for his work with Ballet Frankfurt (from 1984 to 2004) and The Forsythe Company (from 2005 to 2015), and his input and work were vital to the development of *Synchronous Objects*, made in collaboration with Norah Zuniga Shaw and Maria Palazzi (Palazzi et al. 2009). They co-developed a notation tool using visual cues from Forsythe's piece *One Flat Thing, reproduced* (*OFTr*). Forsythe has, therefore, been placed closer to 2010 on the practitioner/choreographer half of the scatter chart (Table 1), on the same latitude as Zuniga Shaw and Palazzi, who are placed within the author/ theoretician

quadrants at approximately the same distance from the meridian. *Synchronous Objects* was the prototype for the 2013 Motion Bank project, which is the choreographic tool available for public use (deLahunta 2010) containing several examples of 'dance scores', all created with this interactive application. This tool offers material production possibilities through a choreographer's interpretation of the tool, so for this reason Forsythe has been situated on the chart in relation to contributors who exist in similar spheres.

3.3 Choreographic Systems

To further position this study, I distinguish between computer-dance relationships and dance and technology applied to choreography. At the Second International Conference on Computational Creativity in 2011, Kristin Carslon, Thecla Schiphorst and Philippe Pasquier presented their version of a computer-assisted choreographic system, with 'Scuddle: Generating Movement Catalysts for Computer-Aided Choreography' (Carlson et al. 2011). They proposed a way to deconstruct and articulate dance creation across three stages: *movement*, that investigates and produces movement material; *sequence*, that links the newly generated material into sequences (phrases); and *choreography*, that weaves these sequences into a dance piece. As a result of Schiphorst's involvement (Schiphorst 1986), and with the development of DanceForms,[33] the authors build on this system as it 'focuses on all three stages of the choreographic process, allowing complex movement to be designed and viewed with a high level of detail' (Carlson et al. 2011, p.124). Carlson et al.'s chart contrasting DanceForms and Scuddle with other existing systems that includes Tour Jeté, Pirouette, Web 3D Composer, Genome, Dancing, Evolution, and pre-1990 systems can be found as Appendix IX (page 170). The chart breaks down each system into the stage of the choreographic process it affects, the source material, the data-altering mechanism, the final selection method, how the choreographic data is shown and the level of level of fidelity to movement. This chart helps to demonstrate the range of choreographic systems that exist to help highlight the gaps in this field of research.

To cite one example, in their *chor-rnn* choreographic system Louise and Luka Crnkovic-Friis have created an algorithm that uses machine learning to gain an understanding of how a performer-participant dances (Crnkovic-Friis and Crnkovic-Friis, 2016). Their algorithm acts as a choreographic tool to predict what the next movements might be. Using MoCap technology to capture the dancer's movement, they tested their avatar after approximately ten minutes, six hours and forty-eight hours of learning. Only after the latter did the system begin to understand the joint relations, syntax and style. They contextualise this progress through '[…] state of the art speech recognition models [that] use 100+ hours of data ([which is] considered to be a major bottleneck in that field of research)' (Crnkovic-Friis and Crnkovic-Friis 2016, p.123). They continue by clarifying that their system '[…] is currently limited to producing choreography for one dancer and cannot not yet generate the semantics in choreography' (2016). In a similar area, the choreographer Wayne McGregor (see also section 3.5 below) collaborated with Google Arts & Culture for 'Living Archive', a project which captured twenty-five years of McGregor's repertoire to inform an

[33] Previously called LifeForms and documented through Schiphorst's MA thesis.

algorithm that could suggest vast ranges of choreographic options in the style of a particular dancer using avatars (Girschig 2019). However, when (understandably) questioned about the potential of this technology to make choreographers obsolete, McGregor clarified that he and his dancers remained the source material (see also Section 7.4 about the next steps for this research, p.107), and the creative decisions remained with him.

These parallel perspectives and their exploration of how algorithms may be integrated into choreography have helped to establish the groundwork for this study. A key difference between the systems described above and my system is that although they both use avatars to reconnect the digital data materialised from their respective choreographic processes with the real world in real time, there is no physical link from digital technology to dancer. My study integrates a wearable device as a scaffolding for the dancers to receive physical sensations (vibrations) to translate and communicate digital data back into the physical realm. While the interpretation of artworks is often subjective, I see no evidence that the aim of these pieces was to promote dance as a form of resistance against digital technology developments, even-though they do apply bespoke versions to explore new creative territory, perhaps to encourage further debate.

3.4 Wearables and Body-Tech

A key component of my choreographic system is the body-tech exoskeleton. It is the catalyst for instigating movement in the participants that acts as the sender and receiver within a technologically mediated choreographic process. The body-tech apparatus built for this research is described in Chapter 5, which discusses the choreographic practice in detail. Wearables are generally worn products embedded with technology designed to execute a specific task, whereas I use the term body-tech (see also section 1.4 on page 22) to encompass the larger surface area they cover, and propose it as merely a device to enable the delivery of vibrations to different points on the dancers' bodies. Although this study integrates this form of technology within choreographic practice as research, its relevance is underscored by the increase in wearable applications over the last ten years (Ameen et al. 2021). Ferreira et al. go further, suggesting that 'The use of wearable technology by consumers is part of this contemporary technological revolution' (2021, p.1). To further define what that means, this section outlines some of the related developments within this rapidly advancing field.

One wearable technology device, created by Google, that has been widely adopted[34] is the FitBit, which is a watch-like bracelet that tracks the heart rate during exercise. It is linked to a smartphone application that processes and reports the user's physical activity against set metrics. Among other wearable products that are designed for accessibility is the SoundShirt, developed by Ryan Genz and Francesca Rosella at fashion technology brand CUTECIRCUIT (McMullan 2019). Their long-sleeved garment has micro-actuators embedded throughout the material construction that can 'hear' sound and translate it into

[34] Revenue from the FitBit in 2021 was US$1.21 billion (Laricchia 2022).

vibrations '[…] that allow deaf users to feel music on their skin' (Marchese 2019, para. 1). The design and distribution of wearables has reached such a level that an interactive online taxonomy, Chimerawearables.com, has now been established. Although still a work in progress, the project is a collaboration between Karthik Ramani and Luis Paredes at Purdue University and Danielle Wilde at the University of Southern Denmark (Ramani et al. 2020). Revealing the breadth of the field, it contains 804 versions of wearable technology from across the globe. In addition, a classification system, the European WEAR Sustain[35] project, seeks to develop and establish best practices for the ethical, sustainable creation and use of wearable technology in Europe. It is also an online platform to facilitate collaborations across disciplines, and it has culminated in the production of an open-source Sustainability Strategy Toolkit (Baker et al. 2019).

Within performance, research on wearables for applications in dance and choreography has been carried out by the fashion designer Michele Danjoux and the dance-technology choreographer Johannes Birringer. They both work with choreography using forms of sonic wearables in parallel to their academic outputs (Birringer and Danjoux 2009). Both are also co-founders of the Design and Performance Lab, which 'explores convergences between physical movement choreography, visual expression in dance/film/fashion, wearable design, and real-time interactive data flow environments' (Birringer and Danjoux 2019).

During her doctoral studies Katie Rees also developed body-worn technology in the form of bracelets to inspire movement in dancers. She had a similar approach in that she also used wanted to learn 'how vibration is understood by dancers within the process of improvisation' (Rees 2022, p.254) to experiment with affecting dance choreography. She also carried out choreography sessions in Studio Wayne McGregor with some of the company's dancers. The links with elements of my research are evident; however, her prototype designs differ in that they are intended mainly for the wrists and are not shifted around the body to try different effects, as I did through my harness design. Further, her digital touch prototypes (as she calls them), 'were coded to produce a repeated sequence of vibration effects, which [she] refer[s] to as a loop',' (2022, p251). This evidences a further deviation from my inquiry because the vibrations delivered through my apparatus came from a remote 'base' controlled by a human enactment of an algorithm, inserting an element of surprise. Its design is intended to be primed for an intelligent agent (or AI) to decide its own pattern of sequences, thereby injecting a different variety of unexpectedness in a creative process. Furthermore, while each of Rees's bracelets had either 10 (right) or 123 (left) vibrating sequences each, the repetition of the same sequence was to test more prolonged experiences with the dancer participants.

For the choreographic workshops, Rees's involvement employed a different approach in that she learned the phrases that her participants created, generating her own embodied understanding of their experiences, unlike my decision to remove myself from this performative aspect. We both alternated our

[35] WEAR Sustain 2021, https://wearsustain.eu/

roles and the sites we used between prototype-making in the studio and researchers in the dance studio, yet Rees opted to engage multiple participants from undergraduate dance programmes, rather than pursuing a different type of connection with a minimal number of participants who are professional dancers, over extended periods of time. Overall, rather than exploring agency through the sender-receiver dynamic in a communication system through choreography, Rees's thesis aims sought to investigate how kinaesthetic awareness and digital touch might affect creative movement choices through technological implementation (Rees 2022, section 1.2, p.15). But her thesis section on wearable technology and haptics does reconnect in that her 'research does not seek to emulate realistic versions of touch through digital means but instead seeks to explore how digital touch might be used as a stimulus for movement creation' (2022, p.38).

Kate Sicchio and Camille Baker, also working within the field of choreography, collaborated by adapting vibrating motors from mobile phones and embedding them into costumes to 'instruct' the movement of dancers (Baker and Sicchio 2015, p.249). However, the data they used had previously been collected from a fitness tracker. In her practice, Sicchio has also experimented with algorithms through use of the t-SNE[36] technique, 'that visualizes high-dimensional data by giving each datapoint a location in a two or three-dimensional map' (van der Maaten and Hinton 2008, p.2281). Sicchio used this algorithmic process to reorganise collages into different arrangements as choreographic impulses for participants (Sicchio 2019).

3.5 Digital Performance

Dance is an exceptionally vast field capable of reaching an array of audiences globally. Choreography is certainly paramount in its creation, and – thankfully – its end result is often public facing through performances. The ways it accesses this vital community is also changing through technology, and Alexander Whitley is one prominent choreographer pushing digital interventions to the forefront of the contemporary dance field. Some of his recent works have been positive moves towards using digital interfaces to assist with choreography, and perhaps enable those without choreographic or dance training to engage with the field. His work sometimes has a flashy and striking aesthetic, of which *Overflow* is a good example (Whitley 2019). In collaboration with digital artists Unchartered Limbo Collective, *Anti-Body* (Whitley 2021) deploys a MoCap version in which the dancers wear strap-on markers to affect the giant screen behind them on the stage in real time, posing questions like 'Are organisms just algorithms?', and 'Is life really just data processing?' It represents a performance work that also uses dance to explore technological deployments in society, focusing on the 'tensions facing humanity as possibilities for life in a disembodied form become ever more real' (Sadlers Wells 2021). The approachability of these works beyond the confines of research are encouraging to see, particularly with the extent of viewership afforded by top-tier platforms like Sadlers Wells in London. Although not yet at the execution (or budget[37]) level of

[36] Stands for t-distributed stochastic neighbour embedding.
[37] According to the UK's Companies House, Alexander Whitley Dance Company's revenue was 22% of McGregor's in 2023/24.

McGregor's later works, Whitley and his company have a comparatively short history[38]of making digital performance work, so there is still space to evolve. In a related endeavour, last year Whitley was the creative director for a publicly-funded research project to develop and test a user-friendly motion capture tool called Otmo, whose aim is to be equally accessible for non-dancers. While an admirable pursuit, it still comes across as somewhat gimmicky and not necessarily effective for investigating the underlying human movement and computer technology relationships. The interface does offer potential, particularly for its ease of use, but like McGregor's Living Archives choreographic assistant developed with Google Arts & Culture, it functions mainly through visuals, still requiring human interpretation to re-link the virtual to the physical world.

Digital technologies in performance have also been utilised to affect and enhance the audience experience through sound and light. Instituto Stocos is prime example of a company playing in this arena, particularly with their piece *Embodied Machine*, whose bio-material based costume design enraptures the piece with an alien mood. Artistic directors Muriel Romero and Pablo Palacio ask: 'is it possible to examine, in depth, our understanding of embodied creativity using forms of artificial intelligence?' (Palacio and Romero 2022, artwork description), translating body expressions into light and music as a response. They devised a method for associating the moving body with performative cues during live performance with minimal lag. I see a connection with my work in that a direct/visceral connection with the body is being explored with the assistance of digital technology, yet this work appears less about the exploration of movement language, and more about a different version of algorithmically supported live dance performance. A common theme is that these technologies are getting closer to the skin. This is true of my body-tech exoskeleton, but aside from the beetle husk-inspired back carapace piece I made in 2018 (see section 5.3 on page 75), my aesthetic might be considered as mechanical or sectional/structural rather than organic. Yet as seen with the work of Stocos, bio-materials, or those with this perceived aesthetic, are becoming more prevalent with the osmosis that is happening between embodiment, digital technology, performance and art creation. Marco Donnarumma calls himself a media and performance artist, director, composer, and theorist, pushing this burgeoning field and defying categorisation, but encroaching upon Stocos' work. Distributed AI[39] and protheses play a key role in some of his later works, including *Ex Silens* (2024) and *Eingeweide* (2018), sometimes resulting in audience members claiming difficulty in experiencing his pieces, but reactions like this – particularly as AI is employed – demonstrate a nod in a similar direction to what I am trying to do through dance with digital technologies physically affecting the human body.

3.6 Conclusion

To conclude this chapter, I will summarise what I derived from the artistic practitioners who have been and currently are operating in areas related to my research. In the interests of brevity, I have tried to include

[38] Whitley's company dates from 2013 and Studio Wayne McGregor began in 2002 (it used to be Random Dance Company).
[39] 'Distributed Artificial Intelligence refers to the implementation of AI services across multiple networked devices or systems to optimize performance and address challenges such as network traffic and low latency requirements,' (Janbi, Katib and Mehmood 2023, hyperlinked definition in Highlights section).

those with a greater level of connection to my work, but there are of course several other artists, researchers, creative technologists, and other practititoners who could also have been included in this chapter.[40] This review process is not exhaustive, but did enable me to critically consider:

1. That there are already several choreographic systems in existence, some of which date back several decades, and that are also concerned with integrating forms of digital technology in the creative process of dance choreography;
2. That investigating the point of initiation of movement in dance has been well researched and documented, including within contemporary dance; and
3. That adaptations and deployments of AI can already physically touch the body.

But also that a choreographic system that incorporated physically tangible inspiration for movement during improvisation in its design had not yet been developed to gain understanding into the possible effects of AI on our bodies. And, crucially, that artistic works specifically promoting dance to resist the advancing developments of AI and other digitally-based intelligent agents is fertile ground for this research to inhabit.

[40] For further references relevant to this subject, it could be helpful to also look at: Mika Satomi; Jun Kamei, Kate McCambridge and Jacob Boast; Huang Yi; Ava Aghakouchak; Jonathan Chaim Reus; and Abel Enklaar, among others.

4 HYBRID METHODOLOGY

> 'Dancing is just discovery, discovery, discovery.' Martha Graham (Dance Critics of The New York Times 1985)

4.1 Practice as Research

Because I was placing human beings at the core of the technological design and development referred to in Chapter 1, I sought the input of two professional dancers as research participants to help inform the development of the wearable prototypes and choreographic system created for this research enquiry. In support of this strategy, in this chapter I will describe the methodological framework and methods I employed for the resulting hybrid methodology of this research. This foregrounds the practice I detail in subsequent sections, which I have entitled *Machinatia*.

There has been much debate about the types of practice research that are considered acceptable within academic circles, including those in the institution in the United Kingdom where I was based for this PhD. When employing Practice as Research (PaR) as a framework from which to carry out scholarly enquiry, some researchers do not distinguish between practice-*based* and practice-*led* research. Yet the creative writing researcher R. Lyle Skains claims that this distinction breaks new ground and cites Linda Candy's definitions of these two PaR sub-categories (Skains 2018). Considering that my research is driven by practice, it stands to reason that I would support the expansion of this methodological framework in academic research. Therefore, I consider it logical to class this research as practice-based rather than practice-led. To extract the key differences I, like Skains, will also refer to Linda Candy's considerable body of work on practice-related research, not only because she is widely cited[41] on the subject, but because her explanations are more easily grasped outside academic circles (an important audience for this research). She defines practice-based research as:

> …an original investigation undertaken […] to gain new knowledge partly by means of practice and the outcomes of that practice. In a doctoral thesis, claims of originality and contribution to knowledge may be demonstrated through creative outcomes in the form of designs, […] performances […]. Whilst the significance and context of the claims are described in words, a full understanding can only be obtained with direct reference to the outcomes. (Candy 2006, p.1)

Through the processes of prototyping and improvisation, the outcomes of my practice (as research) are a wearable physical computing apparatus and choreographic material, which are in themselves original. Although referred to throughout this thesis, in the next two chapters (5 Machinatia and 6 Findings) I directly reference the outcomes of the acts of creative practice carried out as part of this doctoral study. Although there are certainly links between music and dance, my choreo-technological practice emphasises the creative practice, but situates it within the work of related authors, theoreticians, and practitioners, as laid out in the literature and practice (Chapter 2, p.29 and Chapter 3, p.53, respectively), whereas music practice as research can '[…] consist […] entirely of the creative practice, with no explicit critical exegesis deemed necessary. The creative artefact is considered the embodiment of the new knowledge; emphasis is

[41] In 2014 ResearchGate listed Candy's paper as having been read 72,780 times and cited by 267 people.

placed on creative exploration and innovation in the given artistic practice' (Skains 2018, p.85). At present, the interdisciplinary positioning between contemporary dance choreography, human-centred computation and body-tech design (see Figure 10 on page 21) I have taken for this research allows me to borrow from each field. However, in line with the weight I give to dance as a medium for addressing the research questions, I do not consider my position to be static. Instead, like the systemic philosophy I explained in Section 1.6 (on page 26), my placement is also in motion.

The Integral Material section at the beginning of this thesis mentioned that the primary vehicle used to investigate the research aim and questions has been practice. And that, as the thesis title suggests, this practice seeks to challenge the way recent digital technology advancements, such as those that employ AI to generate human-like outputs, have been devised more for the benefit of Silicon Valley Big Tech companies' shareholders. This positioning also draws from some of Graeme Sullivan's writing about practice as research. Although his claim that '[…] the aim of research in the visual arts is to provoke, challenge and illuminate, rather than to confirm and consolidate' (Sullivan 2010, p. 174, Quarini 2015, p. 58) mentions visual forms of artistic expression, it is not inconceivable that this methodological framework could be applied to communication and performance arts, such as those I focus on in this study. Now that I have explained the standpoint from which this research was planned, I will now elucidate the methods employed within this framework to address the aim and questions of this inquiry.

4.2 Multi-Methods

Due to the interdisciplinary nature of this research that builds on my own lived experience, I have drawn from choreographic, radical constructivist, ethnographic and autoethnographic methods to build the hybrid methodology described herein. The methods I pulled from these various methodologies were strictly qualitative, resulting in the multi-method rather than mixed-method hybrid methodology that ultimately came through for this research. The first two methodologies mainly offered useful methods for the choreographic workshops I carried out with the dancer participants. I have combined them in the sense that improvisation was a technique I used from choreographic methods to develop choreographic material, and test the effects of the physical computing apparatus the dancers wore in part of these experiments. My familiarity with this method comes not only from being taught some of the techniques during my university undergraduate degree, but from the many times I was asked to come up with movements and/or technique exercises in the recreational dance classes I took from the age of six. Although I did not recognise it at the time, I was exercising a rudimentary form of physical thinking (see again Section 1.6) when trying to respond to my teacher's request for dance steps to fill in a count of eight[42] for her choreographic piece. This embodied understanding of the potential for improvisation in a choreographic research context allowed me to experiment quickly and freely with the participants. Their own firm grasp of improvisation in contemporary dance also produced fruitful workshops.

[42] Dance timing is often counted in measures of eight beats, particularly in jazz, musical theatre, and ballet.

I also drew from ethnographic methods such as semi-structured participant interviews and observation for the workshops. These are elaborated upon in the findings (Chapter 6 from page 92), where the audio and video interview recordings constitute the bulk of the data analysed, so I will not go into detail here. Ethnographic methods are common in design research because they lend themselves well to trying to understand the user experience when creating a product, service or system. The body-tech I built for the dancers can be considered as (fashion) product, as they are essentially accessories for the body, and my choreographic process employs both human and non-human actors as the nodes within its system structure. These well-established co-creation methods for prototype development are cross-disciplinary, and have been enshrined in government policy via the Design Council, which is the UK's national strategic advisor for design. The fifth of their 'Seven tenets of human-centred design' is 'Follow your users' lead and needs'[43] (Design Council 2004, #5 online). However, the focus of this research is not ethnographic methods used in design and development: rather it draws on these existing design methods as part of its hybrid methodology.

4.3 Dance as Communication

> 'We often describe dance as an exemplar of non-verbal communication but I have realized that the 'product' may be without words but the process of creativity is heavily reliant on them.' – Living Scores by Wayne McGregor (deLahunta et al. 2004, p.69)

Returning to the interdisciplinary positioning chosen for this inquiry, this has facilitated the multi-methods that were employed within the framework of practice as research. Referencing McGregor's quote, if we consider dance choreography as a communication system broken down into sub-sections (much like spoken language) some parallels with radical constructivism arise. Dance scholar Henrietta Bannerman 'explores western theatre dance as meaningful, despite it difference from language or discourse' (Bannerman 2014, p.65). Her research considers the perspectives of linguists (Saussure), philosophers (Margolis), anthropologists (Hockett), and dance practitioners (Cunningham, Alston), and eventually concedes that 'that the meaning-bearing capacity of dance does not justify the view that dance is a language, but that nevertheless dance is structured like a language' (2014). I agree with her conclusion, to focus this research on the relevant aspects of dance: parallels between forms of language within communication. However, I do not borrow her essay's positioning in terms of the use of the word 'language', in that she regards it 'as the verbal and textual means by which we interact on a day to day basis,' (2014). Like McGregor's use of words in the creative process of choreography, in this context I equate the hierarchy of spoken language to dance movement: individual motions as words; phrases like sentences; collections of phrases like paragraphs, and so on. With this trajectory we can then reasonably consider dance as a form of communication, helping to frame the radical constructivist methodology in this research. I have drawn upon my lived experience of training in, performing, teaching and choreographing dance to select the qualitative methods best suited to investigate my central research

[43] This tenet declares: 'Gathering different user perspectives will feed into how you make your product and what materials you choose' (Design Council 2004).

questions. To provide depth, I will first provide some background to this methodology and connect it to dance practice.

As this research draws on my background as a dancer and choreographer, elements of radical constructivism have offered a useful approach in trying to understand how society and artificial intelligence can exist through more symbiotic means, tested through contemporary dance choreography methods to sustain dance as a form of resistance against intelligent digital agents like an AI. The philosopher Ernst Von Glasersfeld, considered one of the forefathers of this methodology, qualifies the radical strand from the standard by 'suggest[ing] "to know" actually should be understood as 'to know how to make"' (Powers 2001, p.77). Aligning with this suggests that my learned experience of how to make dance integrates more naturally into this research. Powers' definition has also connected with this knowledge-building process in stating that it 'replaces this observer-independent model of knowledge with the idea that knowledge is comprised of conceptual structures created by individuals in a fashion congruent with their experience and perspective' (2001). To complement the interconnectedness of systems in contemporary society, this same approach may be used to draw from the experience of the fashion industry outlined in the Preface (see p.12) and Introduction (see p.24).

Von Glasersfeld often uses the context of education when describing radical constructivist methods, as it is also concerned with the acquisition of knowledge. However, he differentiates between 'training' and 'teaching', proposing that educators 'are often better at the first than at the second, [and] do not always want to maintain the distinction (von Glasersfeld 1996, p.10 (200 of the book))." Although he does submit that 'in both, communication plays a considerable part' (1996). While I have not oriented my research specifically for teaching or training, I do borrow from this methodology by positioning myself as researcher-choreographer collaborating with participant-dancers. Traces of a teacher-student dynamic exist if we view 'the teacher's task [as] […] providing a set of stimuli […] to condition the student to "emit" behavioral responses […]' (1996, p.11 (201 of the book)); however, other similarities are limited. A distinction lies in avoiding the directing of the participant or encouraging learning, and instead fostering an equalisng arrangement to reduce the imbalance of power. During the choreographic workshops, I tried to make a conscious effort to behave less like a director and more like a facilitator, to encourage open and visceral responses from the dancers, for example.

Communication as 'the physical signals that travel from one communicator to another' does play a role in the methods employed through the use of 'speech and the visual patterns of […] writing in linguistic communication' (1996). Described later in this chapter, the series of verbalised terms, single numbers, and incremental counting I called out as 'instructions [for the participant] to select […] [verbalised and physicalised] meanings from […] which, together with the list of agreed signals, constitute[d] [a] "code" of [our] particular communication system' (1996). To supplement this process in the choreographic workshops carried out as part of the practice of this research, observation, word association, semi-

structured interviews, audio recordings, video recordings and photographs were employed, thereby blending with ethnographic methods, to support the development and documentation of the research.

By considering dance as communication through movement, this perspective functions well in that the 'sounds of speech' are like movements. Von Glasersfeld establishes further parallels when considering 'the constructivist point of view, this feature of communication is of particular interest because it clearly brings out the fact that language users must individually construct the meaning of words, phrases, sentences, and texts'. I adapt these meanings to a choreographic context by using words as movements, phrases as short collections of movements, sentences as movement phrases, and texts as more complete sections of a dance work.

4.4 Research Through/From Body/ies

Linking to the earlier section on embodiment (3.1 on page 53), I place the body at the centre of knowledge generation for my research, my practice and in life more broadly. Many years of lived experience of fashion and dance, my Master's and this PhD have produced an understanding of the body as a site for knowledge generation which is now quite natural for me to design for, choreograph with, research through, and reflect upon. The collaborative moments of those experiences have also allowed for this perspective to extend externally, incorporating others, thereby allowing exploration of bodies in physical and virtual spaces alongside the interfaces between them. I am certainly not alone in this revelatory emerging area: there are more experienced scholars who have been investigating this subject as the main thrust of their research. Jennifer Parker-Starbuck and Roberta Mock are two authors who not only use the body for knowledge production, but also refer to it within a performance context. In their book chapter 'Researching the Body in/as Performance' they clarify: 'the use of in/as in the chapter title points to our consideration of body-centred research under both rubrics (as well as their blurring), […] many of whom are as invested in researching bodies "as" the locus of performance as they are researching bodies "in" performance' (Parker-Starbuck and Mock 2011, p.210). To show how their explanation connects with my positioning of the body in this research, I have borrowed their blurring technique but adapted it to 'through/from' and used the both the singular and plural for body/ies to respect the shared nature of the choreographic research I pursued in this thesis. It was not only through my own body or and experience that a contribution was generated, but also from the bodily experiences of the participants and collaborators who were involved throughout the process. Parker-Starbuck and Mock further identify certain researcher profiles by stating that 'we consider certain researchers to be body-centred because their enquiries – whether from a performance-making, spectatorial or historical perspective – are provoked by and increase understanding of particular bodies' (2011, p.211). Although dance choreography is often geared towards creating some kind of performance, I am using it as a method of inquiry to address my research questions, but I also consider the moments my choreographic system is in action as performance. I reference the history of Martha Graham's work in sections 1.5 and 5.1 (pages 24 and 71, respectively), but I do not link my place within this research to her historical importance as an important

figure in modern dance. Instead, it is the technique she devised, codified, and performed, built around the contraction, release and spiral reinterpreted through my own training, performance and study, that presents the most valuable contribution to my central argument. And while I have been a spectator to many dance pieces, rehearsals, exams, and workshops, my role in this research oscillated between researcher and facilitator in this choreographically led inquiry. Observation formed part of my multi-method approach, but my spectatorial role (for some moments) also functions in the context of my acceptance of Parker-Starbuck and Mock's definition of a body-centred researcher. Incidentally, when discussing how to ground a research inquiry through methods and means, I appreciate the authors' succinct statement that 'if bodies are placed at the centre of research processes, then research questions and methods must be inflected by corporeal concerns' (2011, p.213). Centring my research on those very concerns is precisely what I have tried to do, and thus enshrine it in the thesis title.

Although I realise the authors refer to a specific theatrical text (*Theatre and the Body* by Colette Conroy) rather than a dance-based work, when I first came across their approach to explain the relationship between bodies and theatres I rejected it, as it felt auto-centric or self-important. But upon further reflection and reading about positioning the body-centred researcher within the inquiry, 'exploring the body as a locus of power' (2011, p.217) now makes more sense if I reorient the phrase by replacing the final word with 'rebellion'. This is because although I am not necessarily working within a theatrical context (aside from perhaps Workshop 3, that was demonstrated in a university lecture hall to an invited audience), I am investigating how the body connects to performative settings – both physically and digitally affected ones. And through this process of discovery, it has become evident that I need to consider the dancing body as a form of resistance in the face of corporeal signature capture by digital technologies.

4.5 Balancing Methods

Connecting back again to embodiment and Hetty Blades' response about paying attention (in section 3.1), Parker-Starbuck and Mock have a similar view but one that offers a further facet by involving other bodies too, much like my adaptation of their chapter title. They clarify: 'rather than discovering, observing and explaining, the fundamental methods of body-centred research are locating, sensing and listening to the bodies around us, to our subjects, to each other and to ourselves,' (2011, p.233), thereby addressing the continual need for body-centred research to maintain a balance between focusing on others alongside our own bodies. This latter perspective should not be demoted when navigating between self as researcher, artist/choreographer and (to some extent) designer, provided that autoethnographic methods are recognised. Mark Edward's concept and definition of 'mesearch' as a me/thodology is a useful reference for this thesis in that the author also works from embodied practice, drawing on his two decades of dance experience, transferring this embodiment into his research practice. He coined the term 'mesearch' as a way of increasing clarity for a non-academic audience, which is a community that this thesis also tries to reach through less opaque language. His current research and practice blend autoethnography, mesearch and performance, relating to, but still differing from, my own. I include his diagram showing how he

visually encompasses autoethnography, mesearch and performance in his research practice, promoting accessibility (see Figure 15). I empathise with his struggle between artistic practice and the feeling of forcing it into academic research: 'self-expression was lost, masked or hidden behind a smokescreen of expectations from the scholarly community' (Edward 2018, p.37) which also addresses the subjectivity in his research trajectory.

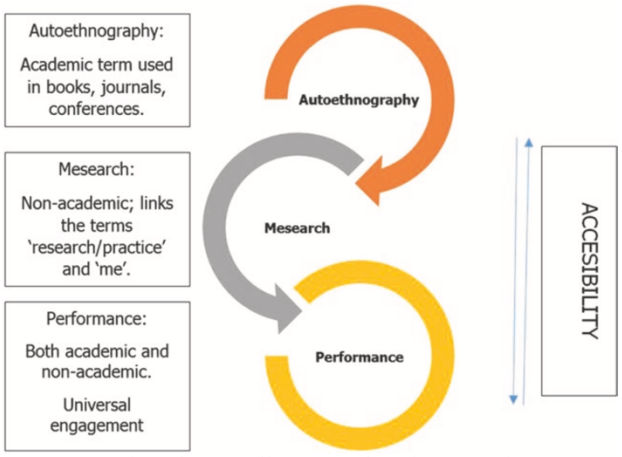


Figure 15: Edward's map illustrating how he interrelates autoethnography, mesearch and performance to promote accessibility in his research practice (Edward 2018, p.37)

Despite a key reference in his research being age and the ageing process, he uses it as a universally recognisable experience to illustrate how increasing its visibility 'within the performance arena' supports the 'need[…] for it to become normalised,' (Edward 2018, p.40). I do not refer specifically to age in my practice or this research relative to myself, the research participants or those I have cited. However, if I were to boldly replace the notion of the progress of *age* with that of *digital technology*, arguing that increasing its visibility within performance contexts promotes its acceptance/normalisation and by commandeering its capabilities for artistic purposes, my research is positioned closer to Edward's. Using this comparison, I am also trying to use dance performance as a form of activism, although here I would not say 'progress' but rather a deepening permeation of digital technologies. I do, however, relish his borrowing of Deirdre Heddon's use of the notion of 'dislodging'[44]: 'dance needs older visible dancing bodies which can dislodge and move ageing and ability discrimination',[45] (2018) as it evokes the notion of redirecting, reorienting, or indeed course correcting from our present path.

While elements of autoethnography, and indeed aspects of Edward's mesearch, do form part of my methodology for this research, there is a distinction in Edward's particular way of focusing on the self. While I reference my past experience, training and education as informing part of the embodied knowledge acquired over the years, this research is less concerned with my reflections on what I have done through this PhD process, the effect of choreographing on myself or considering what these processes/experiences meant in the generation of knowledge. True, I did test some of the prototypes on my body, scanned myself in three dimensions (see the next chapter on page 74), and situated myself in the research on several levels, but I intentionally worked with other participants to learn from their experiences, embodied knowledge, and visceral understandings to carry out the research practice in the dance studio, linked to my prototype building using their feedback and improvised responses. This could

[44] '…the challenge that continues to face practitioners is that of navigating a path between dislodging dominant cultural representations by showing other representations drawn from experience' (Heddon 2006, p.31 in Edwards 2018, p.40)
[45] This recalls artistic director Jiří Kylián's founding of Nederlans Dans Theatre 3 in 1991 which 'was dedicated to showcasing dancers over the age of 42, (Jacob's Pillow Dance Festival 2018, video caption for Evergreens). I became aware of this pioneering company through former Artistic Director and Prima Ballerina of the National Ballet of Canada Karen Kain performance with them in the year following her performing retirement (Reed Doob 2013, para. Retirement from the Stage). Kain was also one of the first members of that the National Ballet School alongside Nadia Potts, who taught me during my undergraduate, hence my interest in Kain's career.

be viewed as echoing my fashion industry experience – where you were chiefly designing for another persona or body, hence the use of fit models among other techniques (although I recognise this is also drawing from my past) – but I also felt it necessary to distance myself from the choreographic workshops to balance some of the inherent subjectivity. The autoethnographic methods I employed – or, 'mesearch [has] not [been] an indulgent act of solipsism: it [has been] self-critical, self-analytical and reflective,' (Edward 2018, p.42) as well.

4.6 Conclusion

To conclude this chapter, I have outlined the overarching Practice as Research framework I used and I have demonstrated how it supported the multi-methods approach drawn from choreography, ethnography, radical constructivism and autoethnography, through an embodied perspective. From here I will describe the different acts of creative practice that formed my research methodology, all geared towards using dance choreography to understand the effects of AI on the human body.

5 *MACHINATIA*: CHOREO-TECHNOLOGICAL PRACTICE

Machinatia is how I have titled my choreo-technological research practice, which has materialised through a series of choreographic workshops. Borrowing from Graham technique, in which movement originates from a deeply individualised contraction, I explored choreographic development by artificial instigation through custom-built wearables. These remotely operated garments are the result of prototyping with different materials and constructions. They act as translators, catalysing digital material into physical material through the dancers' improvisations. The physicalisation of computational data generated during these experiments may be re-input into this creative process, conceptually aligned to how an AI can advance itself through machine learning, although the dominant agents within my choreographic system are human. Through the hybrid methodology employed for this research, this chapter covers the trials carried out over the course of this study. It begins with the basis for initiating movement in Graham technique, and then shows the corporeal digitisation techniques tested as a means of understanding the leap from the physical to the digital through my own body. I then describe and illustrate the wearable prototyping processes I tried, through material and construction technique exploration, first without any form of physical computing apparatus. This is followed by a discussion of the electronics used to translate the remotely communicated digital data into vibrations, and how the body-tech was built to house this technology. The research participants are then introduced to situate their roles within the choreographic workshops that are then presented and described. As this chapter focuses on my creative research practice, which is sometimes ephemeral, aesthetic and/or material, photographic and diagrammatic examples have been included throughout in an effort to mirror their live presence. These practice elements are loosely listed sequentially, as some occurred consecutively while others overlapped.

5.1 Initiating Dance Movement

Further building on my experience and training, the key principles of Graham technique foreground a connection between the initiation of dance movements and how I might replicate this sensation ‘artificially’, using vibrating motors.

During my dance performance degree I was trained in Graham, which centres on the contraction, release and spiral, that are the pillars of the technique. The training was rigorous and repetitive, and encouraged us as students to discover what these concepts meant within our own bodies. It was a process of understanding how this technique can permeate every aspect of our movement, whether in the studio, on the stage, or in the street. These technical tenets have become part of me and remain to this day, influencing how I physically interact with the world.

Figure 16 Toronto Dance Theatre, Earle 3rd from left, Beatty 7th from right, DuPlisea centre, sitting, Randazzo 4th from right (Unknown photographer, 1979).

The Graham contraction is a point of initiation for movement in this technique. Former Martha Graham Company dancer and teacher Gertrude Schurr expands on the beginnings of Graham technique: 'in developing her technique, Martha Graham experimented endlessly with basic human movement, beginning with the most elemental movements of contraction and release' (Martha Graham Center of Contemporary Dance, n.d., History section). Further, the ex-Graham Company dancer and teacher (who also had roots in German Expressionism), Jane Dudley '[…] refers to a major principle in Graham dance, that arm movements are motivated from the muscles in the back or from those around the shoulder blade area' (Bannerman 1999, p.12), when explaining the point of initiation for an arm movement. This particular aspect of the Graham technique is what helped inform the design and construction of the body-tech prototypes: again the designs follow dance. She also '[…] recounts that Graham herself used a descriptive metaphor to teach the process of the contraction and release and it is one that was passed on to students at her school in New York and by those company members who taught in London in the 1960s. She suggested the use of mimicry: 'you have to hiss like a snake or like a cat hissing so that it's got truth'[46] (1999, Reynolds 2002, p.16). David Earle, Patricia Beatty, and Peter Randazzo (Figure 16) all trained at the Martha Graham School in New York in the 1960s before returning to Canada to found Toronto Dance Theatre in 1968 (Ochrymovych 2019). One company member, Karen DuPlisea (seated under the ladder in Figure 16, and second from right in Figure 17), became a faculty member at Ryerson and extended this lineage to her students, including me. DuPlisea was also known for her visual descriptions,

Figure 17: Seastill, choreographed by Patricia Beatty in 1979. DuPlisea 2nd from right (Photography: Andrew Oxenham).

[46] This is also referred to in the next chapter when the participants and I speak about 'trust in movement' during the workshops.

often paraphrasing Graham's explanation '[…] it is a movement into something. It is like a pebble thrown into the water, which makes rippling circles when it hits the water' (Bannerman 1999, p.36). These visualisations, via DuPlisea, helped to identify the richness of the Graham technique in exploring the initiation of dance movement. Again, allowing the dance to lead the design, my memories of these experiences in class and understanding in my body enabled a sound grounding from which to start building prototypes that could house vibrating motors in view of providing artificial instigation. In parallel, I went through a process of discovery, trying to understand what it meant to digitise a body. For this, I used my own, simply because of access and the ease of reducing health and safety concerns for the trials.

5.2 Corporeal Digitisation

Von Glasersfeld's analysis of communication within a constructivist perspective on education aligns with my own training and performance experiences. For interactions with my research participants, I built on and extended this

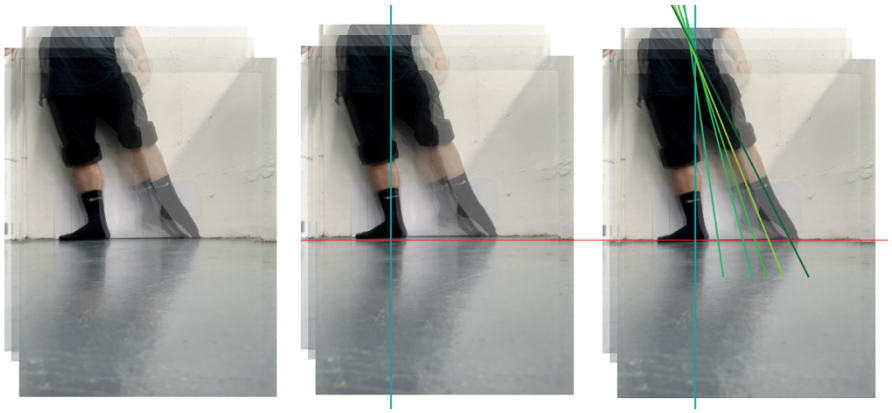


Figure 18: Digitising the tendu in 2D (Guérin-Garnett 2019).

Figure 19: Digital imagery overlaid capturing a tendu over multiple sessions (Guérin-Garnett 2019).

methodology to devise activities for gathering qualitative data. One issue was determining how to connect the intangible materiality of digital data with a tangible living body. The multidisciplinary perspectives used in this research already presented a challenging complexity because the number of variables increases with each additional discipline. Therefore, the empirical data formats within which this research is framed would be equally difficult to replicate. To help mitigate this, I revisited my training by looking at movements common to most dance techniques: the *tendu.*[47] I photographed myself executing this movement with a digital camera, overlaid several of them to examine alignment and drew over the images in Adobe

[47] Dance terminology, meaning 'to stretch' or 'stretched'.

Figure 20: Rokoko suit and OptiTrack MoCap system trial (Guérin-Garnett 2019).

Illustrator, as a form of corporeal digitistion (Figure 18). Repeating this movement over several sessions enabled my rediscovery of where a tendu should be initiated. Without any form of external stimulus, I needed to first feel what was technically correct.[48] This process was intended to solve the issue of connecting the physical and digital worlds. It also refamiliarised me with the feeling that was necessary for me to understand how it might feel for others. Overlaying the digital images from these trials

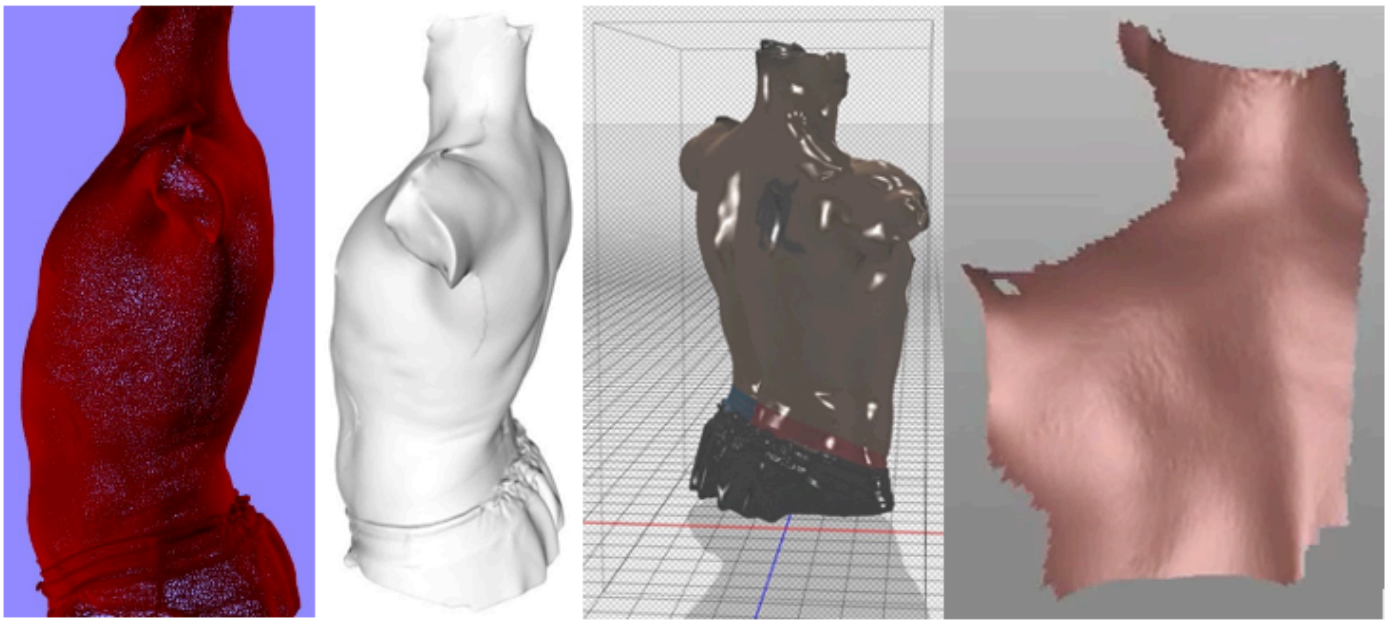


Figure 20: Four techniques of 3D scanning my torso (Guérin-Garnett 2019).

documented and complemented this test (see Figure 19). Capturing myself this way was an attempt to understand what digitising my body felt like doing a movement I know deeply, to use this knowledge in bridging the digital and physical sensations in our bodies. In hindsight, however, these tests were insufficient, and did not yet reveal how AI might be integrated into creative processes. To deepen the feeling (and therefore understanding) of being digitised, I tried capturing my static body through 3D

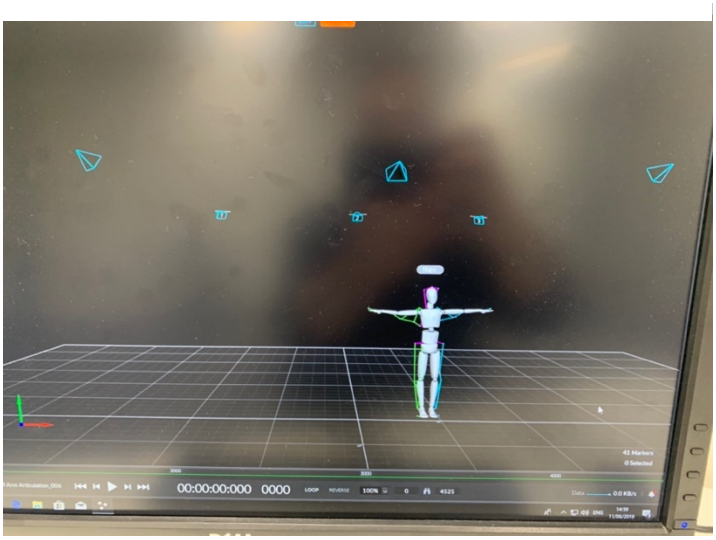


Figure 21: My body visualised through MoCap software (Guérin-Garnett 2019).

[48] The technique to correctly execute a tendu in ballet or contemporary dance.

digital scanning techniques (Figure 20), and my moving body with MoCap technology (Figure 21). The experience was fascinating, particularly the brief video showing the sections of body being absorbed by the scanning device (included with the practical element of this thesis). It should be acknowledged that this experiment was liberated by the fact that any transmission of my corporeal information would be with my explicit permission, because it was captured within the controlled environment of an academic institution. Once such parameters are breached, the human data collection limitations afforded by this protection alter.

For the MoCap I trial, after calibration[49] I experimented with different postures and brief phrases of movement to visualise my dancing in digital form.

These trials constituted a further building block of the choreographic system I was constructing by acquiring basic knowledge and experiences of body digitisation techniques. From here I moved onto material exploration to prototype my body-tech designs.

5.3 Body-Tech Prototyping

Figure 22: Some preliminary leather prototypes using moulding techniques (Guérin-Garnett, 2018).

Having worked with leather during my fashion career provided some basic knowledge of its behavioural qualities. From this experience, I hypothesised that moulded leather forms might allow the right mix of flexibility for the extreme range of motion many dancers are capable of, and enough strength to support technological devices. The first experiments involved wrapping different pieces of leather around hard-surfaced mannequins to get a sense of size, shape and placement. Following the origination of movement in Graham technique I built prototypes that covered the whole of the back (see Figure 22). To add further flexibility, I sectioned the carapace panel into portions using a thonging[50] technique. I embedded patterned pieces of metal, strapping, different kinds of fabric tapes and other hard objects between the leather panels wrapped around the mannequin, and encased the pieces in tightly wrapped elastic and fabric for the drying process. The rationale of experimenting with this debossing was to test the effects of

[49] The process necessary for this set-up whereby you calibrate the suit markers with the nine cameras, so the computer vision software can align your body position with digital coordinates, starting from a stationary position.
[50] This technique uses elastic, cord or a similar material to connect two pieces of leather by weaving it through holes pierced along the edges of the pieces, allowing for space and movement between them.

embedding e-textiles or other physical computing components into the design. This dance-led design process helped to visualise how such wearable apparatus might behave on a living body in motion. Despite the aesthetic successes of this prototype, at that point it obviously did not contain any computing technology. Its size also increased the contact area of the leather with the body of the wearer, resulting in discomfort. The horizontal panels allowed for flexibility along the vertical axis, but not sufficiently along others. This design would therefore not allow for the contraction, release or spiral, nor would it accommodate the hyper-mobility of many dancers' spines. However, these revelations did inspire iterations that could retain the material choices by reducing the size of the moulded leather computer mount, and increasing the straps securing it on the body (Figure 23, centre and right).

Figure 23: (Left) pager motor suspended in silicone connected via an e-textile; (centre) trembling structure mounted in smaller moulded leather support; (right) support mounted with elastic to abdomen (Guérin-Garnett, 2018).

5.4 Physical Stimulation Options

With the material construction advances of the wearable prototypes, I shifted to the problem of mimicking the physical instigation behind Graham-based dance movement. I subsequently discussed the option of soft robotics for movement stimulation with Sina Sareh.[51] The robotic inspiration came from an experience of seeing Garry Stewart's *Devolution* in 2007[52] (2013), which left a lasting impression on me. I had hoped that threading soft cords through tube casings might mimic the sensation of an instructor or dance partner gently guiding movement, but the set-up was too cumbersome for my body-tech exoskeleton design and did not enable a sufficient range of motion. Activating them remotely was also an issue. From an earlier experience of providing the movement for an animation via an older MoCap model that required wiring attached to a base, I knew that a wireless arrangement was essential for extreme movement like contemporary dance.

Trying to address the issue of bulkiness, I looked again to a past experience, when I received rehabilitation for a muscle injury. Electrical stimulation was used to help the area heal faster (which it did), and these systems already existed. Different intensities of electrical charge were delivered via small pads attached to

[51] Sareh is the Academic Lead in Robotics at the Royal College of Art. Our discussions took place in 2018.

[52] My memories remain clear of this piece: athletic dancers wore bespoke, active apparatus manacled to different parts of their bodies, becoming extensions of their skeletons. Each of the 30 robots appeared parasitic to their human hosts (or the inverse?) with its own powerful actuator enabling it to thrash violently, physically altering the dancers' movements on stage. Stewart created this contemporary dance work in collaboration with multi-disciplinary artist, roboticist and researcher Louis-Philippe Demers (Art+Technology 2018) and others for Australian Dance Theatre in 2006.

Figure 24: Testing vibrating stimulus on myself (Guérin-Garnett 2018).

the affected area. While these were generally attached to stationary machines plugged into the local electricity source, smaller, battery-powered versions were also available, leading me to believe that I could adapt this product for my research. However, maintaining adequate safety standards for using electricity to deliver hand-made prototypes on research participants raised the risk level too high.

A further option was suggested by Dr. Sara Robertson,[53] who showed me a simpler option using smart material. A 'trembling structure' (Figure 23, left and centre) is a pager motor connected to a flat watch battery via a strip of a conductive e-textile suspended in transparent silicone. When the battery is pressed, the motor vibrates, much like the feeling of a mobile phone. The device was small and portable, and the silicone casing presented minimal health and safety issues to users. It was not remotely operated, but despite this I saw this as a viable avenue to pursue. Building from this, I decreased the overall dimensions of the mount and alternated the strapping until I figured out a self-testing method (see Figure 24). Despite not functioning remotely, this prototype was able to mimic the sensation of a Graham contraction.

5.5 Building a Remote Vibration System

The next challenge was to translate the vibrating sensations wirelessly to the user. For this I sought assistance from my institution's physical computing workshop technician, John Wild,[54] and with his help I eventually came up with a device that could vibrate remotely without the need for any connecting wires from a base. I sketched

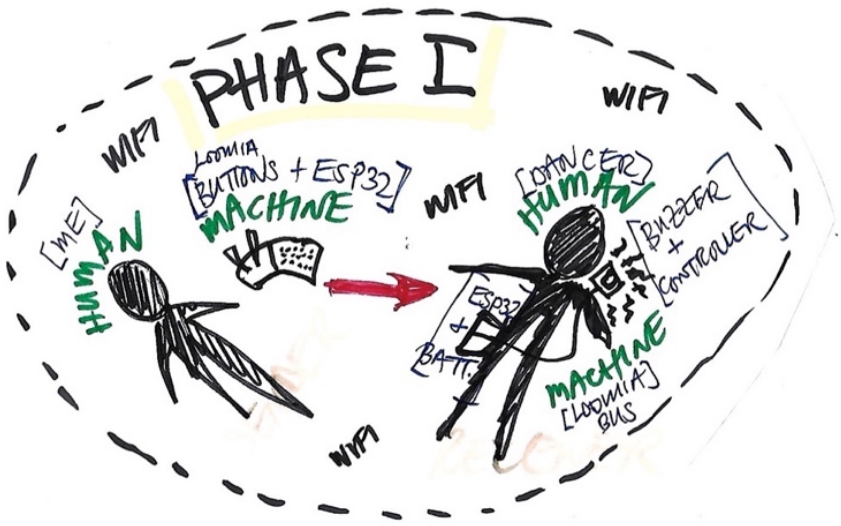


Figure 25: Choreographic system sketch, Phase I (Guérin-Garnett 2020).

[53] The smart textiles advisor for this research project, also based in the School of Design at the Royal College of Art.
[54] Dr. Wild is a physical computing specialist and technician at the Royal College of Art.

out the concept of the choreographic system to explain what I was after (see Figure 25), dividing it into two phases. This thesis only encompasses the first of these, with the second indicating the next steps for this research (see Section 7.4, p.107, for *Machinatia II*). Based on the success of the trembling structure I again used a pager motor to provide a vibrating stimulus. A flat lithium three-volt battery[55] was sufficient for this size of actuator, and could easily be encased within a garment for a dancer to wear (see Figure 26). I mapped out the other components (or nodes) of this computing arrangement to get a rough idea of the other pieces required for this set-up. As with the collaboration with Davis on the algorithmic aspects of this research, my skillset does not extend into electrical or computer engineering. John Wild helped to realise my idea by providing a button (see Figure 27) as part of the stationary base that would send the signals to the battery-powered vibrating node mentioned above. I used an ESP32 microcomputer capable of communicating with another of the same type via Bluetooth or Wifi technology, thereby removing the requirement for wiring between the base node (sender) and the portable node worn by the dancer (receiver). The latter was constructed following the circuit diagram in Figure 28. In line with my intention to experiment with stimulating movement using vibration on different parts of the body, the blue and red wires in Figure 29 were extended so the resistor and three-pronged plug (N) could be grouped with the microcomputer and power source. While the original intention was to use a small flat battery to power the portable node, this required more soldering, which weakened its sturdiness and proved too delicate. A basic portable phone charger ended up being a viable power source, and could be easily

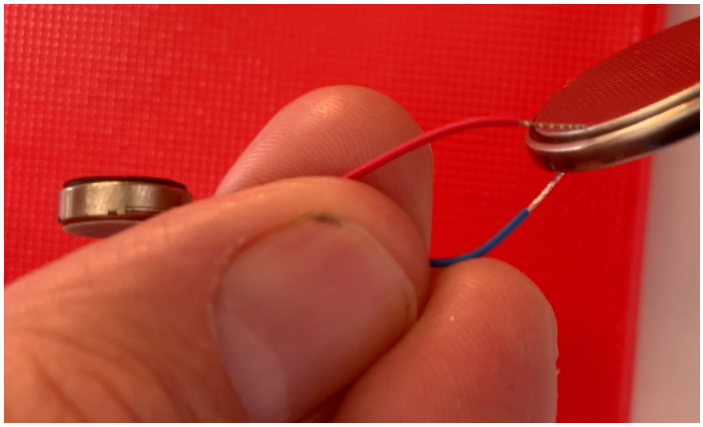


Figure 26: My tests with a 3V battery with a pager motor for vibration (Guérin-Garnett 2022).

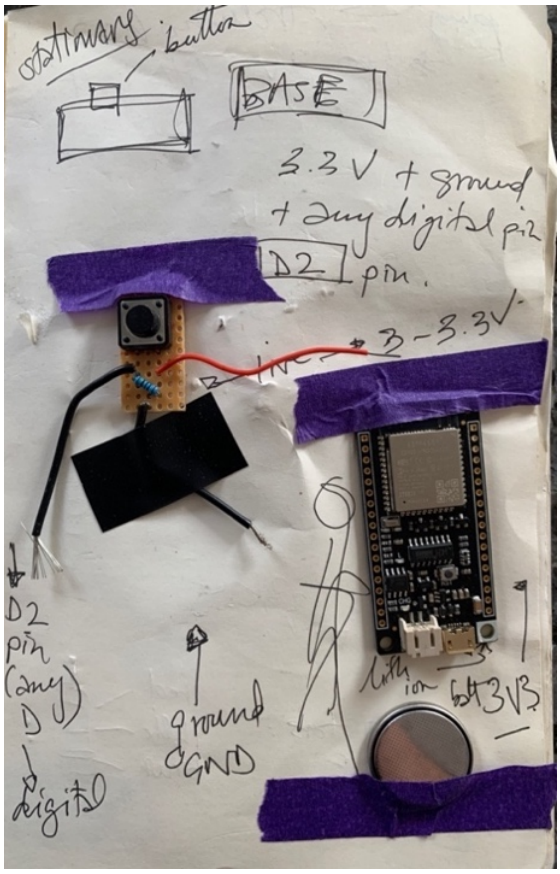


Figure 27: Pre-wired button (left), ESP32 microcomputer (right), and 3V battery (bottom) (Guérin-Garnett 2022).

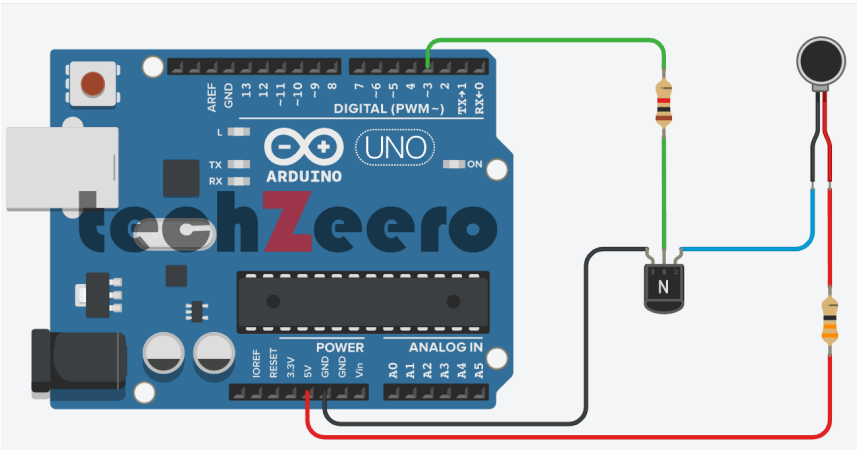


Figure 28: Diagram of the portable node that receives signals for the pager motor to vibrate. The microcomputer is an ESP32 (TechZero 2020, online).

[55] A 9-volt battery produced a stronger vibration but would burn the pager motor out quickly, so this option was dropped.

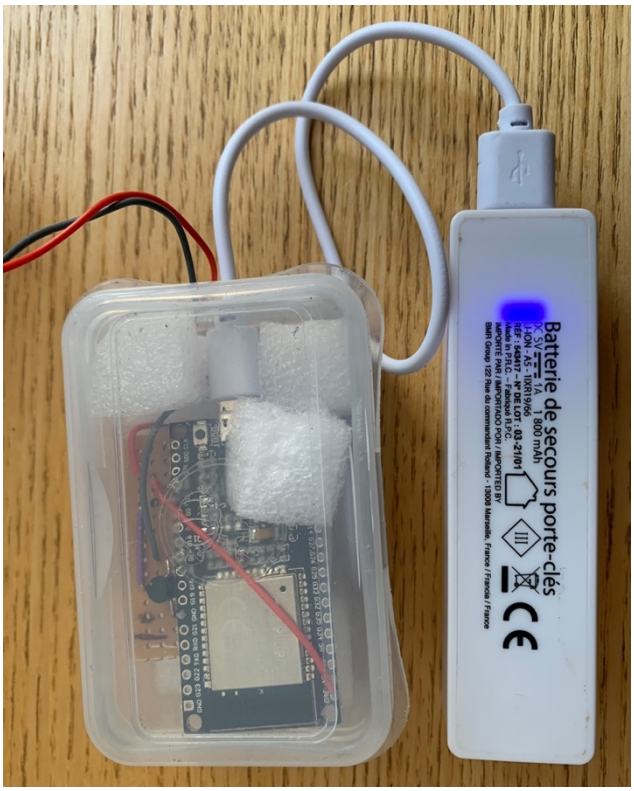


Figure 29: Portable node mounted in a plastic case plugged into a phone charger (Guérin-Garnett 2022).

connected the power port on the microcomputer via a USB cable (see Figure 29). I used a hard plastic case and padded the electronics in Styrofoam cubes to protect it from shock. This whole set-up was easily modifiable, rechargeable and durable, and thereby could withstand extreme physical movement and body sweat. It could then be mounted into the elastic harness I had been building in parallel (see Figures 30 and 31). The vibrating node was reduced in size, containing only the vibrating motor soldered to long red and blue wires. They were mounted on a piece of elastic that could be inserted into any part of the garment, allowing me to shift the point of vibrating stimulation as needed in a live setting with relative ease. Fabric tape was used to attach the motor to the elastic and the wiring was sewn to the elastic for stability. I used Velcro pieces on the reverse side to secure them to the inside of the harness.

The stationary node did not need to be as robust because it would simply be attached to power source via a USB cable. It was constructed using a breadboard, the same ESP32 type as used in the portable node,

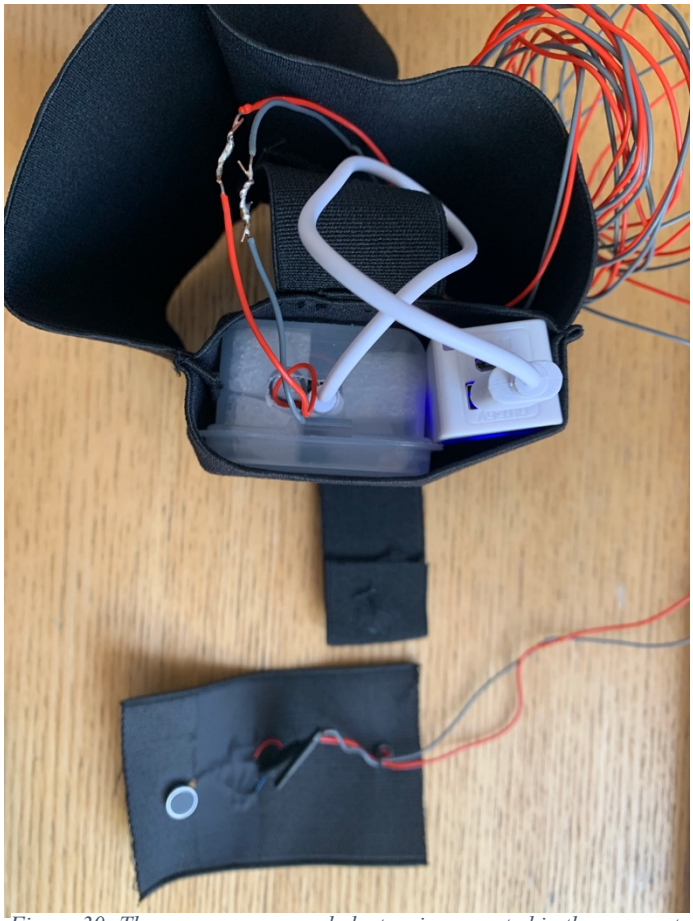


Figure 30: The power source and electronics mounted in the garment (Guérin-Garnett 2022).

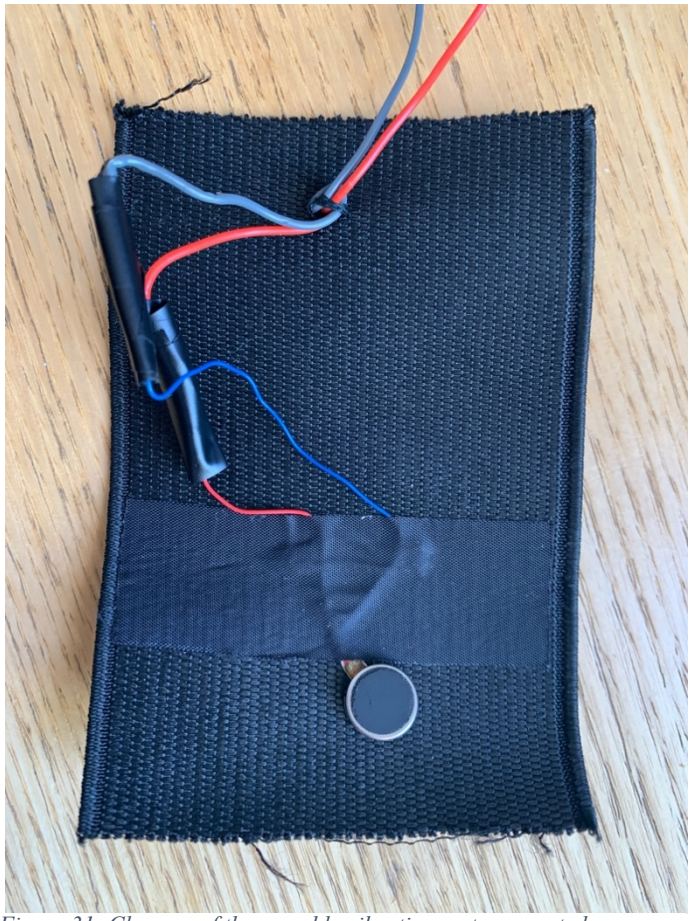


Figure 31: Close up of the movable vibrating motor mounted on elastic (Guérin-Garnett 2022).

a button, a resister, and Arduino wiring (see Figure 32). The Arduino code is included as Appendix XII on page 172.

The first trials with a participant revealed the fragility of the remote vibrating apparatus, so I temporarily remedied the issue by using the programmable vibrating ring function on my iPhone, the steps of which can be seen in Figure 33. ‘Buzz trial 1, 2 and 3’ were three sequences of buzzing I created to test the initial effects of this system on a participant in real time.

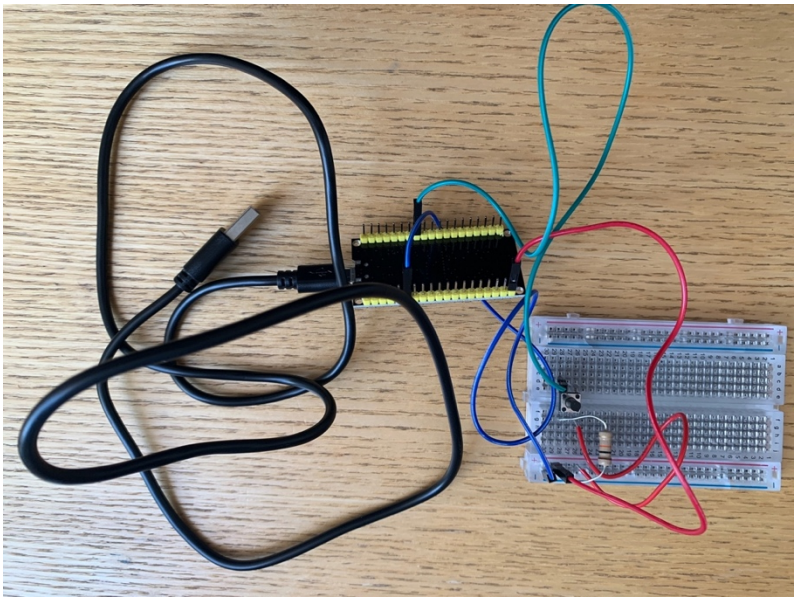


Figure 32: The stationary node ready for attachment to a power source (Guérin-Garnett 2022).

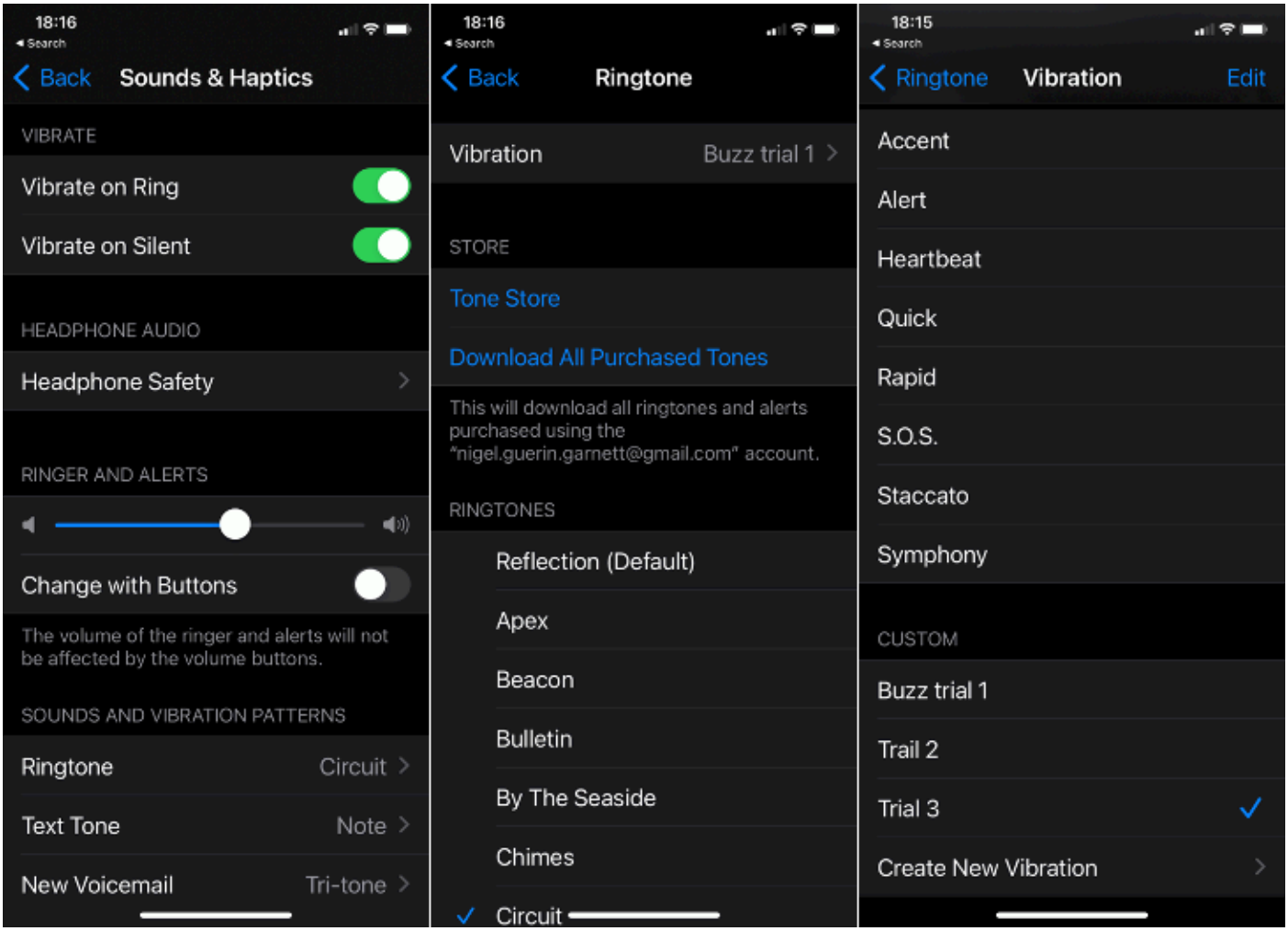


Figure 33: Steps to program your own vibration ring tone sequences on an iPhone XR (Guérin-Garnett).

5.6 Garment Development

Figure 35: Adjustable garment to house the vibrating apparatus (Guérin-Garnett 2022).

Figure 34: Soft elastic harness created for the research participant (Guérin-Garnett 2022).

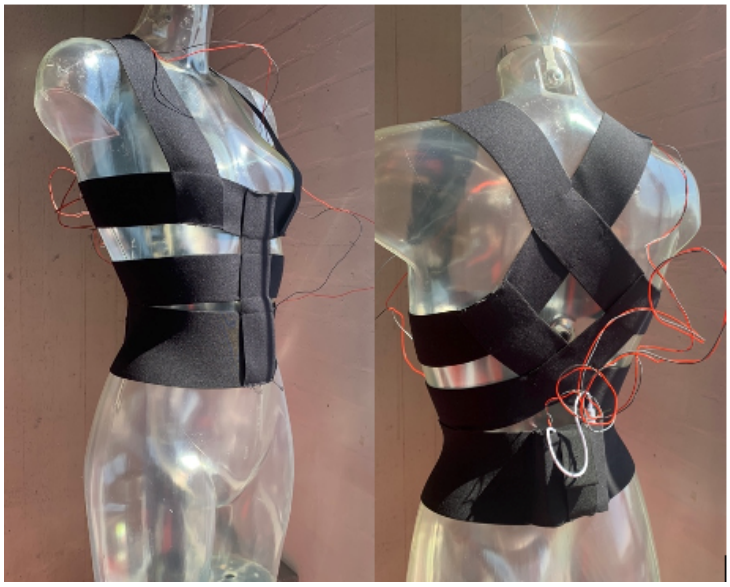


Figure 36: The female version of the harness shown on a mannequin with the vibrating apparatus installed (Guérin-Garnett 2022).

The main aim for my first choreographic workshop was to experiment with different locations of vibration on the wearer to inspire movement, so I needed to create a garment that would allow the pager motor to be moved around the body and the sizing adjusted as needed on the spot. In response to this challenge, I used heavy elastic and safety pins and made a harness (see Figure 35). My past body-tech prototypes using elastic informed this design, allowing Session 1 to take place as planned.

Assisted by the technicians in the fashion department,[56] I developed the design using smoother elastic and fitted it to the specifications of the participants recruited for the choreographic workshops (detailed in Section 5.7). Following my sketches (see Appendix XI, p.171), the result was a fully constructed black harness for each participant with no pins (Figure 34). The vibrating apparatus was mounted in a pouch positioned on top of the sacrum, and the wiring was wrapped around the straps (Figure 36).

[56] Kelly Duncan and Iwona Zabrocka are both experienced garment technicians who have worked in the Royal College of Art MA Fashion programme for several years. They assisted with the fittings and construction of the garments, following my designs.

5.7 Research Participants

To effectively test my choreographic system, I needed to have a sender and receiver, which meant that I could not execute this step in the research by myself. I therefore recruited two research participants, who were professional dancers, and advertised for a videographer to document the choreographic workshops. The call for participants I created can be seen in Appendix I (p.120). Again, due to the multidisciplinary nature and associated complexity of this research, I sought to reduce the number of variables through the recruitment process. I did this by engaging dancers who had followed a conservatoire-style dance education similar to mine, with a focus on modern technique underpinned by a strong ballet foundation. These codified techniques (as described in the Preface on p.12) would mean we would at least have a shared dance language to work from. For the videography I selected a fellow student (Gregor), who had proven experience of filming dance. Jordan was the first dancer I worked with, and he suggested Eileih as the second participant, based on their joint experience of performing in Company Wayne McGregor. Considering the history of McGregor's dance company and his longtime interest in technology, I suspected that dance artists involved with his body of work would have an innate interest in the topic of my research. That both dancers had worked with McGregor specifically in his research projects was also an advantage, as it demonstrated an openness to choreographic research.

As explained further in Chapter 6 (Section 6.3 on page 94), the rationale behind working with so few participants but on an extended basis aligns with Uwe Flick's first of six theoretical backdrops, which is to '[…] work to accomplish genuine rapport with participants in which to elicit confessional reports of lived experiences from which to fashion in-depth descriptions' (Flick 2014, p.2). This approach proved successful, evidenced by how the participants' responses increased in magnitude and detail over time, which was instrumental in trying to understand their experiences, not only of improvising in a dance studio, but also in terms of the source of the movement and being able to verbalise what it felt like. Our discussions developed over the course of the workshops and increased in detail the more we worked together, thereby helping to dispel any uncertainties about working with one or few participants instead of larger focus groups. The choice of this strategy should not be underestimated, as it could have allowed doubts of objectivity or bias to taint any impact of this project. In retrospect, if I had engaged multiple participants for this research stage, the number of variables would compound exponentially. With the breadth and depth of data (covered in Chapter 6) that has emerged from just two participants, it would have been unmanageable to systematically collect, process and extract any useful information. If the project had been planned with a different research design focusing on specific functionalities of the choreographic system through a limited set of questions, then a large participant base might have made sense. But I maintain that this approach is better suited to the next steps of this research.

5.8 Choreographic Workshops

Von Glasersfeld's radical constructivism may also be applied when comparing verbal and non-verbal forms of communication. However, I have expanded this methodology to encompass further levels of understanding and application for this case:

> Once a certain amount of vocabulary and combinatorial rules (syntax) have been built up in interaction with [dancers] of the particular language, these patterns can be used to lead a learner to form novel combinations and, thus, novel conceptual compounds. (von Glasersfeld 1996, p.11)

Here, I applied the choreographic tools and techniques learnt from my teachers to plan the series of choreographic workshops that constitute the practice element of this research. My aim was to create an environment that would allow me to test the components of the choreographic system I had built so far. As previously mentioned, the workshops were broken up into three sessions. This was carried out for practical and logistical reasons, such as participant and studio space availability, in conjunction with the development of the physical computing apparatus and garments outlined in this chapter. Breaking the sessions up also allowed for prototype iterations to occur based on the participant feedback and my observations during the workshop.

5.9 Session 1

To extract as much from the studio sessions as possible, I developed a workshop plan (included as Appendix III on page 129). The structure and choreographic processes I included in the workshop stemmed from my experience of creating original choreographic material through improvisation with established choreographers towards complete dance works for performance.

Considering the multiple variables in this project, I narrowed the scope of Session 1 by using only one dancer. My earlier discussions with Davis about algorithms and Wild about their physical manifestations in my system through vibration had alerted me to the challenge of incorporating each element to their full extent within one PhD. However, the combination of discourse, the review of existing literature and the practice research described in this chapter made it apparent that mimicking the effects of an algorithm on a human could also provide rich insights into my research questions. Echoing Turing's 'imitation game'[57] discussed in Chapter 2 (p.29), a human could imitate machine behaviour by pressing the button on the choreographic system's stationary base in varying sequences. In this scenario, even though the vibrating impulses would not actually come from a mathematical algorithm processed by a computer, the receiver could still respond to the vibrations through improvisations. This meant that the documented experience of the simulated algorithmic process could illustrate potential effects of AI on choreography. As sketched out for Wild, Phase I of the research is what I explored during these choreographic workshops. Developing the workshops in a structured way fostered an environment that offered the participants confidence and providing enough flexibility to allow new material to flow naturally was complex. Before

[57] The Turing Test was originally called 'the imitation game'.

Session 1 with Jordan, I went through my workshop plan as if I was the participant. From this I made some revisions, and then made a detailed plan, which is also included in Appendix III (page 129). To look at digital data within the body in a live setting, I focused on exploring what points of meant for Jordan. To reduce bias, I kept direct choreographic instructions minimal. I had worked this way in the past[58] as a dancer and found it empowering: it often generated richer improvisations, resulting in entirely new choreographic material. Like Graham's visual allegories to elicit truth in the movement, I wanted Jordan's reactions and responses to emerge as unadulterated or uninfluenced as possible.

Figure 37: Terms used to generate movement phrases (Petrikovic 2022).

We went through a process of word association. To kickstart the first workshop, I had made a list of terms related to this research: 'technology', 'data collection', 'human gait', 'automation', 'complex movement', 'simple movement', 'impetus', 'inertia', 'movement ends', 'connectedness', 'reaction', 'stimulus', and 'response'. The responses that Jordan made to these that resonated with me were 'auto-pilot', 'energy', 'impact', 'idea', 'stillness', 'at one', 'surprise', 'answer', and 'reaction'. From these lists I selected three words that I observed Jordan had responded immediately to: 'technology', 'stillness', and 'inertia'.

From here we repeated the process, with Jordan responding physically instead of verbally (see Figure 37). These brief improvised reactions of movement became the building blocks for the remainder of Session 1. We[59] then threaded them together into a phrase of movement.

Drawing from some of the choreographic tools I had earned in university I added increasing levels and types of stimuli to see how it affected the movement sequences. I voiced numbers beginning with 'one', counting upwards to indicate the beginning of the physical form of each new term, meaning Jordan would not know how long it would be until the next number would be announced, asking him to extend or constrict his movements. From this, I moved onto counting at different tempos, asking Jordan to mirror the intensity and speed with his movements. Each time I restarted at 'one' meant he had to begin the next physicalised term, again offering an element of surprise because he would not know when I would stop counting and start again. I then added the first layer of physical stimulus through gentle body contact with

[58] For example, with artistic director Tom Stroud during my tenure at Winnipeg's Contemporary Dancers in the autumn of 2001.
[59] I use 'we' here to respect the more equitable environment I had been trying to create in this first workshop. Both Jordan and I co-created the initial movement phrases.

Figure 38: Fitting the first garment prototype on Jordan, adding the vibrating phone (Petrikovic 2022).

my finger to indicate he should switch to the next term. Although this was fruitful, he explained that my moving around him as he danced allowed for a degree of anticipation, because he could sense when the next contact might come. After these experiments I asked him to perform the phrase to different musical scores, to see how that might alter the movement in comparison to silence.

At this point I introduced the first (grey) garment without any form of electronics and made some fit notes for the next round of prototypes (Figure 38). Once the garment was fitted to Jordan's body, I asked him to walk through some of the movements to ensure nothing was uncomfortable or falling apart while he moved. I then programmed a vibrating sequence in my phone and slid it into the soft pouch before placing it against Jordan's back, held in place by the elastics and larger pins. By calling my phone from another device I was able to imitate the remotely delivered, vibrating, unexpected effect explained at the start of this section. With no instruction apart from asking him to simply allow the vibration to affect his dancing, I asked Jordan to improvise in the space (Figure 39). From there, I asked him to perform the phrase we had just created but with the vibrating phone against his back (Figure 40).

Figure 39: Jordan's first responses to vibrating stimulus (Guérin-Garnett 2022).

Figure 40: Jordan performing a pre-formed phrase with vibrating stimulus involved (Guérin-Garnett 2022).

Later on in the first day of Session 1 we expanded the phrase of movement, using the same technique as before but with three different terms: 'impact', 'as one', and 'idea'. Once this second group of phrases was created in physical form ,and I connected it to the first set to eventually form what I called 'Phrase A'. After embedding this phrase into his body I asked Jordan to perform it without music and then to music.[60] I was testing the levels and types of stimulus on existing choreography to observe any variations.

Gregor joined us for the second day, which I used to build on the first day and develop new variations towards producing a more complete piece of movement. To add a further layer to this process I taught Jordan an existing piece of choreography in a style less familiar to him: modern jazz. For this I used an original piece choreographed for me (plus the rest of the cast) by Vicki St. Denys[61] to Lou Donaldson's *Blues Walk*, entitled *Pulse*, which I performed in 2000 (St. Denys 2000). The aim here was to teach an existing piece of repertory to Jordan, and then rehearse it to achieve the muscle memory required to perform it without thinking about the steps. This is the process dancers go through, usually before performing a piece for an audience. I wanted him to reach this performative state before we added any other form of stimulation (Figure 41).

[60] *Harm Hymn* by Nils Frahm, released in 2018.
[61] My jazz dance teacher and resident choreographer at Ryerson (now Toronto Metropolitan University) from 1998 to 2001.

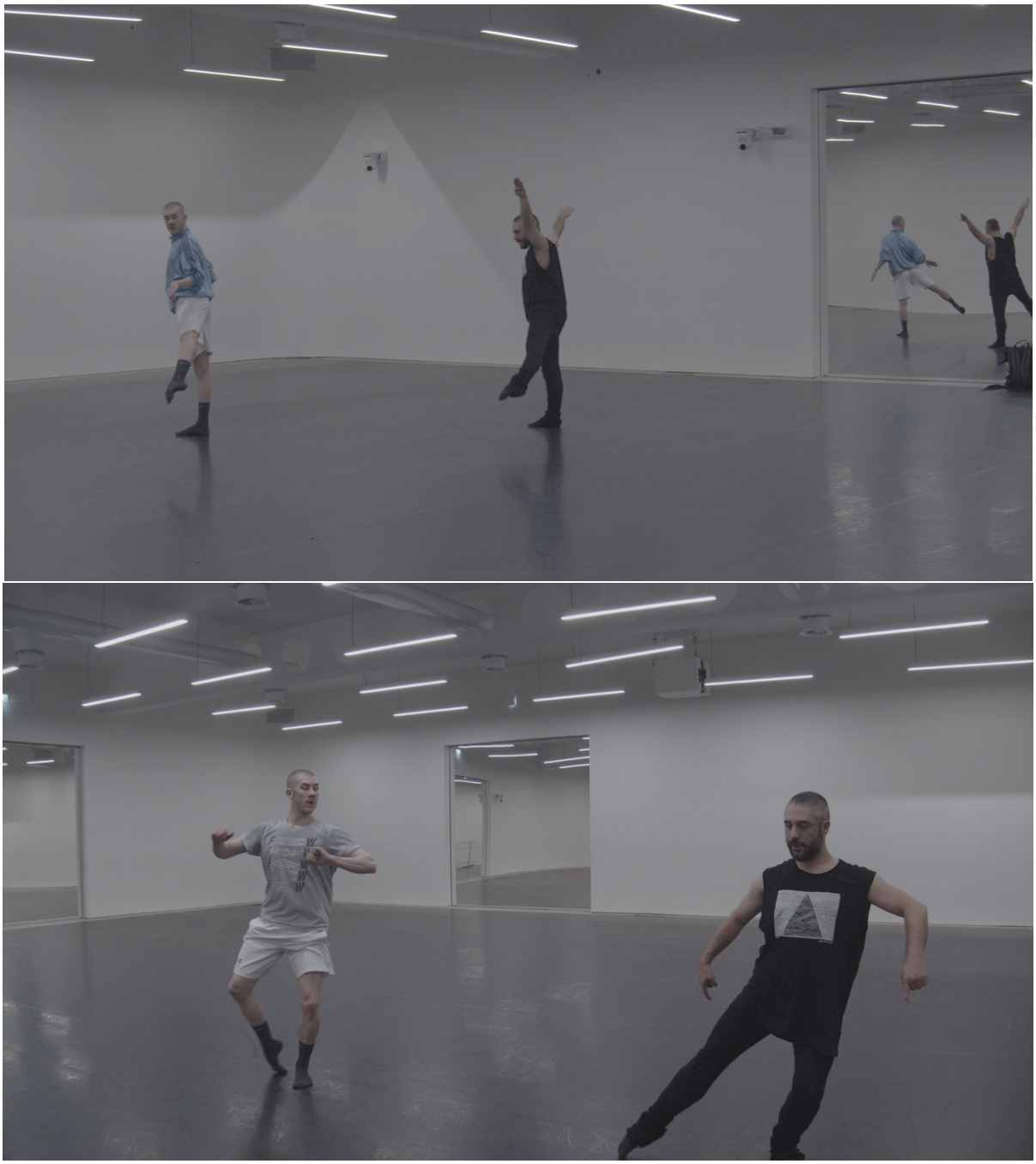


Figure 41: (Above two images) Teaching Jordan St. Denys' modern jazz piece Pulse (Petrovik 2022).

For the remainder of the workshop, I focused on seeing how the vibration-enabled garment affected the movement. We began by revisiting the existing material and went through the same process of layering and adding options, but this time using set phrases.[62] Positioning the vibrating motor on the abdomen,

Figure 42: Jordan trialling Pulse variations (Guérin-Garnett 2022).

[62] Meaning the choreographic material had a specified series of movements.

as I had tried on myself earlier with the trembling structure, elicited a positive response form Jordan, so we used this placement. We tested *Pulse* with four variations: (1) no score with vibration only; (2) using the originally selected score *Blues Walk* with vibrations; (3) using *Parallel Jalebi* (Four Tet, 2013) which was previously unknown to Jordan, plus vibration; and (4) using *Drw Budr* (Hartnoll, 1996), also with the vibrating stimulus (see Figure 42).

5.10 Session 2

Following the technical mishaps of Session 1, where I had to replace the remote vibrating device with my phone, I now had a functioning apparatus ready for insertion into either participant's garment. For Session 2 I invited Eileih to join us. We went through exercises similar to those in Session 1, but I developed material with each dancer individually. In the same way I encouraged Jordan to generate original movements, I wanted a phrase to come from Eilieh. I had asked Jordan not to share details of Session 1 with Eileih in advance of her attendance, to allow her to experience the material building process in a similar manner. This was to elicit her own unique reactions and physical improvisations. Instead, I asked Jordan to write down reflections from our last session with some prompt questions.

Figure 43: Eileih performing her phrase wearing the vibrating apparatus (Guérin-Garnett 2022).

Alongside my now working vibrating apparatus, the other main difference between Session 1 and Session 2 was that I was working with two participants instead of one in the same setting. I also had a garment built for Eileih, so I was able to test her phrase with the vibration device (see Figure 43). As I had been pressing the button (or calling the mobile phone) to cause vibration sequences in the garment for Jordan during Session 1, I then gave the button mechanism to each dancer individually (Figure 44) so they could experience what it felt like to provide some instruction to the other participant. This was also to help reduce bias from my perspective during these workshops. Lastly, I also taught *Pulse* to Eileih so we could

carry out the same test seeing how the vibrations might alter this choreography. I asked them both to perform this repertory piece, alternating the wearer of the vibrating apparatus, to examine any differences in performance (see Figure 45).

Figure 44: Transferring the vibration controls to Eileih, and Jordan improvising (Guérin-Garnett 2022).

Figure 45: Eileih and Jordan performing Pulse, with Jordan wearing the vibrating apparatus (Guérin-Garnett 2022).

5.11 Session 3

Session 3 was focused on fostering objectivity of the experiments from the first two sessions and learning from others' impressions. The 2022 Extended Senses Symposium[63] presented a prime opportunity to get responses from an informed audience. There, following a brief introduction to contextalise the experiment, I demonstrated how the remote vibrating system worked with Jordan as the participant (see Figure 46). Expanding my earlier tests for transferring the controls, some of the audience members participated, imitating instructions provided by an algorithm.

Figure 46: Jordan and I demonstrating the choreographic system to an invited audience (Baker 2022).

5.12 Summary

Using choreography as a method to drive this research, my PaR practice was also informed by the collaborations outlined here and my background, grounded in theoretical research to create the necessary elements of this system structure. The choreographic sessions were the testbed for the material exploration and physical making experimentation described in this chapter, forming a multi-method process that resulted in some wearable prototypes and a wirelessly operated vibrating device to be

[63] This event was co-hosted by the University of Greenwich and University for the Creative Arts and enabled doctoral students to workshop parts of their research via live demonstrations.

encased within them. Led by dance, the cumulation of these methods has been used for insight into the effect of algorithms on the creative process of choreography. The discoveries that were made during these creative research processes are detailed and analysed in the next chapter.

6 FINDINGS

6.1 Introduction

In this thesis I have referenced different parts of my background in the fashion industry and as a dancer, including the Graham training I undertook. The effects of these experiences have been lasting, shaping my research practice over the years. This in turn has informed my choice of methods, research participants, and contextualisation. And while this has provided a rich foundation from which to consider how algorithmic processes may affect choreography, and by extension AI, this has also produced assumptions regarding the results of this study. Therefore, in this chapter I will present these, discussing how the data generated through the research has challenged them. I will also indicate the method of analysis, how I have adapted it for my purposes, and what it revealed about my research questions.

During the workshops carried out as part of the practice aspect of this research, Jordan and Eileih's physical and verbal reactions provided insights that have enriched the research process and helped to identify some next steps. Their responses also serve to strengthen my choice to focus on a practice-led approach instead of a theoretical one. Evidence is offered in the accompanying material submitted with this document that contains video footage of the choreographic workshops from which the data below was extracted.

6.2 Preconceptions

[The participant quotes are taken from the transcripts contained with Appendix II: Data Charts on page 120.]

In line with the ripple effect in Graham technique, I assumed that, for a dancer, feeling vibration on the back would be able to replicate externally the sensation of instigating a movement internally. My expectation was not entirely unfounded, evidenced by the initial experiments with phone vibrations. Jordan explained that this '…was an important theme, experimenting with the phone on my back, the buzzer, and trying to stay true to it rather than adding because what [is] the point of adding if you have [not] found the beginning, the source?' (Bridge 2022). However, Eileih and Jordan's responses shifted this assumption during the tests in which they wore the remotely vibrating apparatus during improvisations. Eileih explained that even though often 'the movement is coming from somewhere in opposition there [is] a ricochet from that point through the body, rather than it just happening to the external […] part that [is] doing the movement,' (Muir 2022). In Session 1, Jordan talked about a shift in location for movement impetus, but related to the feeling of the vibrations delivered by the wearable. He stated that, 'Yes, you can feel [the vibrations] pretty much anywhere but the best way in my head even before you put it into practice is at the hinging joint […] to feel [where] the vibrations [are] coming from.' He mused further saying, '[…] whereas if we [have] [the vibrations] across the back, yes there [is] movement but it would [feel it less] whereas if I had nodes here (shows wrist) I would feel it,' (Bridge 2022). The body-tech prototype iterations are detailed in Chapter 5 (see pages 75 to 80), but it was this input that informed the

relocation of the vibrating impetus, dispelling my earlier Graham-based preconceptions. Shifting the body location for the pager motor of the remote vibrating device required the disparity between the extreme flexibility of dancers and the non-stretch electrical wiring to be resolved. The microcomputer was mounted at the sacrum,[64] but I needed to be able to shift the vibrating stimulus around the body. Otherwise, I would not be able to research the effects of externally provided movement instigation, which would negate the possibility of integrating an algorithm into the system. The subsequent iterations therefore permitted the pager motor to be located using with a circular strap fastened with Velcro. This complemented the options already afforded by the harness-type garments.

In addition to my expectations about the location of the external source of movement instigation, I predicted that multiple types of stimulation would cause confusion about which to use during improvisations, resulting in a negative experience. I tested my theory using the choreographic techniques mentioned in Chapter 4, culminating in the maximum sources of stimulus employed at the end of Session 1 and 2. I explored the effects of altering original choreographic material and repertory with verbal cues, human touch, musical scores and vibrations in view of shedding light on what adding an algorithm might do to these processes. In Session 1, for example, I asked Jordan, 'Now [that] you [have] tried the [original] phrase again with a musical score behind it [following your question beforehand], do I engage with the music or not - I let you choose, what did you end up doing?' (Guérin-Garnett 2022). His response revealed some of his thought process while he was dancing when he said, 'Bit of both. During each individual task, [I was] not really listening to the music but [the] phrasing […] of when to start the next [step] - kind of listening to the phrasing and on next phrase going into the next idea' (Bridge 2022). Which began to dissipate my assumption about potential confusion in this scenario. During a similar test with Eileih, also using the vibrating apparatus, unprompted she identified practical uses of the device in choreographic material generation and dynamic training. She explained, 'What I think is interesting is that my natural movement type is to make everything fluid and quite "one level". And actually this [apparatus] is a tool to force me into different dynamic changes … [it] is interesting' (Muir 2022). After asking her to elaborate, she continued: 'As just an improv[isation] tool, specifically, if we could kind of nail the rhythmical sensation of this, it would be a helpful tool. I mean it *is* that tool now, but that would be another level' (2022). Her responses identified potential applications of this research that I had not previously anticipated, which have shaped the future directions outlined in the next chapter. Consequently, the response fragments cited in the above sections are representative of the interview transcripts collected during the choreographic practice of this research. They were selected because they depict the range of information experienced by the participants. This collection of qualitative data has been mined using the analysis method explained in the next section.

[64] The large bone that sits in your pelvis on which the L5 vertebrae of the spine sits.

6.3 Theoretical Backdrop

Dr. Uwe Flick has published significantly on the theory and applications of qualitative research. In his handbook on qualitative analysis, Kathy Roulston's chapter on interviews lays out six theoretical backdrops for analysing interview data. While the data collected during this practice-based research project has been varied in format, a large portion has been through interview transcriptions. From these options, the following two contain elements which partially align with the nature of this study:

1. Romantic portrayals in which researchers account for their subject positions in relation to participants, and work to accomplish genuine rapport with participants in which to elicit confessional reports of lived experiences from which to fashion in-depth descriptions (e.g., Johnson-Bailey, 2001); and
2. Postmodern representations in which parties to interviews are viewed as performing fragmented, non-unitary selves, data from which may be reconstructed and/or deconstructed using creative analytic practices and arts-informed approaches to analysis and representation (e.g., Berbary, 2011). (Roulston 2020, p.297)

First, I mention 'elements' here specifically, because claiming to align with them in their entirety would be inaccurate. I do account for my subject position within this research, as a large part of the practice of this project has consisted of me working directly with dancers as participants, over a series of sessions, building upon our relatively similar dance training and performing backgrounds, capitalising on our common language to try and deepen my understanding of their experiences during working sessions. Having a shared language with the participants has enabled richer discussions, allowing us to go deeper within the sessions. Despite an expected degree of individuality, we have all gone through similar training programmes, studied contemporary technique, and performed works by other choreographers on stage. These relatable factors in our histories seem to have increased trust and helped foster an open environment in which we have been able to experiment choreographically. The moments of verbal feedback, sometimes after an improvisation session or at the end of the day, are what have constituted some of the richer data that has come out of this study.

Second, generating in-depth descriptions has been a goal, but through the participants' open responses to semi-structured interviews and improvisation exercises. However, I do not consider my viewpoint to be romanticised, because of the shared experience of our background and conservatoire-style training. In fact, I would argue a comparatively opposite stance, because visceral physical responses have emerged as fruitful in the development of the technological interventions that this research has been exploring. I would also argue that I am employing 'creative analytic practices', considering that both I and the participants identify as artists, and we are working by using the art form of contemporary dance for choreographic material development. The research aim is to use our co-created choreography to illustrate more collaborative methods of creating with artificial intelligence. These are in and of themselves inherently 'arts-informed approaches' – this thesis is positioned as art as research, rather than a recipe for a solution, product or service.

Beyond the literature and artistic works contextualising this project, a vital part of the research took place in dance studios with dancers. Detailed in Chapter 5 (Sections 5.8 to 5.11, pages 83 to 90), I planned workshops that built upon my training and experience as a dancer and choreographer. Across the three sessions, 20 digital audio and video recordings were collected,[65] along with a written survey for the participant present in all three sessions, and my research notes/reflections were recorded after each practice day. The collection of transcriptions that I had charted across the three workshop sessions, my written reflections, and the survey response made up data sets discussed in this chapter. They should be viewed in conjunction with the videos submitted as accompanying material.

6.4 Thematic Analysis

The psychologists Victoria Clarke and Virginia Braun have published widely on thematic analysis of qualitative data, and have captured a generalised but clear rationale behind its applications:

> Many reflexive TA researchers do indeed have some kind of social justice motivation – be it "giving voice" to a socially marginalized group, or a group rarely allowed to speak or be heard in a particular context, or a more radical agenda of social critique or change. (Braun and Clarke 2018, p.6)

Using Braun and Clarke's description of the type of data analysis I ultimately carried out, I see those of us who are not on the upper end of Silicon Valley payrolls as a defined group who are not being heard in the context of this particular imbalance of power. This context has not only helped me determine the type of analysis that is most appropriate for this research: it has also shaped an overall approach to my research practice.

After reviewing the prescribed steps of some of the published, discussed and defended versions of thematic analysis, I have formulated my own adaptation. To do this I have referenced Braun and Clarke's more recent version of thematic analysis, which acknowledges their paper 'Reflecting on Reflexive Thematic Analysis (Braun and Clarke 2018), written thirteen years after their original publication on the topic. In the 2018 paper they have refined their originally broader thematic data analysis outline to a few specific sub-categories. One of these is called 'reflexive' which, during the process of analysing my research data, has revealed aspects that have become helpful for this analysis. However, while the authors lay out a coding process, and define further steps as categorisation, theme construction and finally theme definition, they have considered the reflexive approach to be both linear and non-linear, which makes it less clear. If this process is indeed reflexive, I would suggest that it should be non-linear, as flipping back and forth between the data, and the codes, categories and themes that have been identified is both natural and useful within this technique. I have also drawn from the version of coding, and approach to process outlined in Kirstie McAllum and others' 'A Comparative Tale of Two Methods: how Thematic and Narrative Analyses Author the Data Story Differently' (McAllum et al. 2019) Further exploring options for coding, I was also influenced by the more bottom-up content analysis possibilities

[65] Using my iPad and iPhone, with the exception of Petrikovic's videography and photographs, that used professional equipment.

defined in fellow researcher Teresa Kroenung's PhD thesis '*Momentaufnahmen*: Building a Feminist Method of Contemporary Fashion Analysis through the Translation of Helen Grund's Texts'. I include her work here as she also calls into question specific steps of these forms of data analysis, favouring a hybrid viewpoint for interdisciplinary artistic research PhD theses. I have adopted the spirit of Kroenung's soft manual coding technique, which allows for the emerging information to come from the texts in a more holistic manner, instead of counting quantities of words within a specified context. Her technique allows a close familiarisation process to materialise through the texts themselves.

The paper by Mojtaba Vaismoradi et al., 'Theme Development in Qualitative Content Analysis and Thematic Analysis' further differentiates between thematic and content analysis succinctly:

> While the thematic analysis researcher considers both latent content as theme and manifest content as category in data analysis, the content analyst chooses between them before proceeding to the higher levels of data analysis. (2015, p.101)

Although Braun and Clarke draw similar parallels in their outline of the differences between inductive and deductive, this is within their second phase, generating codes, when laying out the practicalities of reflexive thematic analysis. But although they are slightly different specific contexts, they all work in the spirit of enriching definitions and applications of qualitative data analysis. I have looked to Vaismoradi et al. because the context they use is nursing, which is also viewed as a practice. Their paper looks at both forms of qualitative analysis when considering how themes can develop from research studies, but from a practice-based perspective. Given that this research project is also practice-based, my thinking has been that considering practices outside artistic ones could support my versioning of data analysis for this thesis. I have found Vaismoradi et al.'s outline of coding types to be clear and applicable. They have created a table that classifies codes as conceptual, relational, participant perspective, participant characteristic and setting codes, providing examples, and the codes that have been extracted from these codes (see Appendix X, p.171).

The extracted codes given in their example follow a similar summarising strategy to that of Johnny Saldaña via McAllum et al. To adapt my own version, I borrowed from McAllum et al.'s reference to Johnny Saldaña's book *The Coding Manual for Qualitative Researchers* when considering the approach and type of coding. Saldaña offers a clear and concise outline of what a researcher does during this key part of the analysis: they 'symbolically assign a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data' (McAllum et al. 2019, p.4, Saldaña 2009). Furthermore, the McAllum et al. version of thematic analysis cites Braun and Clarke's overarching description of the approach, adding their own qualifiers: 'Thematic analysis is a versatile "method for identifying, analysing and reporting patterns (themes) within data"' (Braun & Clarke 2006, p.79). They specify this further by expanding the versatility of this analytic approach: 'one of its strengths is its flexibility for many different types of texts' (2006). A further reason for selecting thematic analysis as the foundation from which to begin my analysis is the range of potential data sources, listed succinctly by Saldaña: 'interviews, field notes, journals, letters, documents, open-ended survey responses, drawings,

artefacts, photographs, web pages, emails, and non-fiction and fiction literature' (Saldaña 2016). The versatility of this approach has more easily encompassed the range of datasets that have proven useful for this research.

Last, in outlining aspects of qualitative data analysis approaches, Vaismoradi et al. do however posit that 'some researchers […] focus on the explicit description of the content of communication with a limited reflection on its implicit meaning'. Like Kroenung, I have tried to avoid this, preferring to try to extract the deeper thematic narratives of data within the context of their sources.

6.5 Coding

As in all the versions of thematic analysis cited here, I went through a process of reading, re-reading and re-reviewing the raw data. Like other researchers working with participants, interviews generated most of the data. The variety of datasets came via discussions/discourse in the studio, dance improvisation sessions, my reflections written in diary style immediately after each day of choreographic workshops, and a more formalised survey for the one participant who was present in all the sessions. The summation of these data points has generated the datasets, from which the thematic analysis approach described here has been carried out. Using the raw data files, I copy-edited the texts to reflect what occurred during the recorded interviews, or videos of the studio working sessions, as accurately as possible. All files were saved in a chronological formatting order, so that the titles of each file indicate when the file was recorded and what sort of material it contains. For example, the first file is titled 130422_improv_response_3_JJB+NGG.MOV, meaning that it was recorded on the 13th of April 2022: it is a dance improvisation session, and in video format, with one of the participants plus me. The perhaps complex titling and storage organisation has mainly been to enable ease of access and referencing over time, including during the composition of this thesis and thereafter. This also echoes McAllum et al.'s

Table 4: Coding and clustering progression (Guérin-Garnett 2023).

CODING 1	CODING 2 (selection in grey)	CLUSTERING 1	CLUSTERING 2
included in Appendix II (too much detail to include here)	communication method	communication method	communication method
	options	options	options
	decision/choice	decision/choice	decision/choice
	visualisation	visualisation	visualisation
	limitation	limitation	limitation
	lived experience	lived experience	lived experience
	dualism	dualism	dualism
	reversibility	reversibility	reversibility
	initation	initation	initation
	layering	layering	layering
	truth in movement	truth in movement	truth in movement
	origination	origination	origination
	improvised real-live moment	improvised real-live moment	improvised real-live moment
	impetus	impetus	impetus
	location on the body	location on the body	location on the body
	in opposition	in opposition	in opposition
	all at once	all at once	all at once
	unexectedness	unexectedness	unexectedness
	heightened state	heightened state	heightened state
	external instruction	external instruction	external instruction
	internal instruction	internal instruction	internal instruction
	physical sensation	physical sensation	physical sensation

more cyclical version of thematic analysis, with their summary, 'as with any qualitative strategy that involves interpretation of the data, thematic analysis, even once "completed", remains open to ongoing revision rather than being closed or finished' (McAllum et al. 2019, p.5). This approach has helped to synthesise large amounts of data collected over several workshops and via multiple means.

My coding process involved going back through all the transcripts again from the beginning a few times to ensure I had some consistency in the data selected. I then highlighted similar (or the same) words and phrases within each passage across the whole spreadsheet document. After repeating this process several times, from the highlighted phrases I extracted and recorded summative concepts. These are captured in Table 4.

My process referenced Kroenung's soft manual coding, which itself deviates from Mayring's qualitative content analysis outline, by questioning the fourth step, which is intended to validate the study against others within the discipline. In Kroenung's thesis she outlines her reasoning:

> Mayring presents, this fourth step implies that a study is only valid when it can be triangulated or replicated, which – as addressed previously in this chapter – arguably falls into common preconceptions of scholarship in which experiences are only legitimate if they can be checked against existing evidence. (Kroenung 2020, p.135)

In Kroenung's discussion and eventual rejection of Mayring's fourth step, she goes on to underscore her position, stating:

> Where Mayring sets out a fourth stage in the analysis, a triangulation with other studies, which could be said to carry an implication that the experiences and stories and their entwined analyses are not sufficiently valid on their own. What I am proposing here is that the meaning and interpretation of these texts resides within the text. (2020, p.136)

I go one step further in questioning Mayring's definition in terms of his use of 'replicated', as this end-goal is in fact an antithesis to (dance) improvisation, which was a key mechanism used throughout the studio sessions. These sessions were seeking quite the opposite of replication in that they used experimentation to try and understand how the body-tech prototypes affect choreography. However, I do compare that choreographic process to the practice of writing. In the chapter on methods I try to explain the way I built the workshops – based on my choreographic experience – using the building blocks of written composition: words, phrases, paragraphs, full pieces of text, and so on. This parallel links Kroenung's version of coding to mine within qualitative data analysis, following her definition: 'Meaning is inferred from the text's message, and the procedure to procure that meaning is what I describe as a manual soft coding' (2020, p.136).

Kroenung also looked at more traditional coding procedures, going through the rules and testing some of her interview transcripts and the translation of Grund's texts in this manner. She also experimented with the traditional content analysis coding process to carry out similar tasks:

> After conducting a few test runs of coding the data generated from the interviews I realised that even though the coding was giving me an idea of the frequency with which the interviewees mentioned one topic or another, it felt very detached from the way I had engaged with Grund's texts, and it was difficult to apply to the thickness of the steps of translating, transcribing and describing. (Kroenung 2020, pg. 136)

It appears that Kroenung's soft manual coding may be more akin to what has already been naturally happening during the recording, transcription, digestion, and processing of my datasets. Kroenung outlines her process as follows: '[…] the semi-structured interviews were conducted after having internalised Grund's methods, and after their conclusion and subsequent transcription the interviews were first evaluated for key moments or epiphanies' (2020, p.137), excluding Mayring's fourth triangulation step. Similarly, I have also ended up looking for crucial moments pertaining to the research content and aims within the texts of the transcripts after an extended process of familiarisation and digestion. Apart from the fact I have leaned towards thematic analysis coding versus Kroenung's coding, we are both challenging some norms of standardised coding processes to analyse qualitative data. However, while Kroenung uses references and sources that delineate this into masculine (rational thinking) and feminine (intuition), I see no gender divide within my study aside from that of the participants. I would argue that adding this separation to the matrix would serve only to confuse this already multi-disciplinary context.

From Braun and Clarke's 2018 publication (and others writing about thematic analysis and/or content analysis), it has not made sense to approach this analysis by predetermining (potential) themes, and extracting the data from the transcripts that could relate to these themes. Instead, the codes have emerged from digging into the datasets, re-reading them over several days, going back over them and further clarifying codes from the materials. One example is whether there should be a differentiation between 'impetus (behind)' and 'origination (of impetus)'. Impetus is obviously the common word here, but these two codes have conceptually different meanings, and therefore applications to the material being analysed. The former has come to be broader, and somewhat more generalised, than the latter, which specifically considers where the impetus is coming from – across the body or otherwise.

6.6 Theme Generation

One of the key intentions of an analysis such as this is to reduce 'large data sets to a manageable set of common themes' (McAllum et al. 2019, p.4). However, through my own data analysis I have not sought a strictly reductionist tactic: I have instead preferred to allow for a holistic translation from the explicit snippets of information coming from the transcripts, through to more abstract, conceptual directions.

By going through the datasets repeatedly, I found that the terms that materialised suggested further abstraction – a process of fine-tuning the words into those that better captured the real essence of what was emerging from the texts. And although I was initially unsure whether I was pulling out themes in advance of a sufficiently rigorous coding process, upon reflection I realised that instead I have deepened the process into a two-level coding process, where the second has bypassed Braun and Clarke's next

steps of reflexive thematic analysis, which is categorisation, and proceeded to theme construction. The non-linear standpoint has again better served the nature of this research, the data it has generated and my relationship to both.

To try and avoid over-complicating this analysis, I referred again to McAllum et al. who 'adopt the metaphor of scissors, string, and glue to describe the tools available to the researcher conducting a thematic analysis, whether manual or computer-assisted' (2019). I looked at their reference to Sarah J. Tracy's art and crafts positioning, almost literally applying her technique of '[…] cutting, pasting, hole-punching, piling, and stringing together the data' (2019). These have both been helpful ways to think about how to tackle the theme-building stage.

Building from the manual process of writing out the two levels of codes defined after the familiarisation process, I then clustered the codes into groups. Over several rounds I looked for relationships between codes based on the shared experiences of the choreographic workshops, my embodied knowledge constructed over the course of this project, and my background in the field. During this repeated manual process, some rich clusters came through, which are displayed below in Table 5.

6.7 Theme Definition

Table 5: Rounds of thematic development (Guérin-Garnett 2023).

THEMES 1 (random order)	THEMES 2	THEMES 3	THEMES REFRAMED
individual	individual		
layers/options (of stimulus)		layers/options (of stimulus)	
spontaneity	spontaneity		
variables	variables		
honest(y)		honest(y)	honest(y)
surprise/unexpectedness		surprise/unexpectedness	
specific instruction	specific instruction		
agency		agency	agency
movement dynamic		movement dynamic	movement dynamic
location on the body	location on the body		
tension/interplay		tension/interplay	tension/interplay
sensation	sensation		
		haptic perception	haptic perception
		impetus origin	impetus origin
			stimulus type

As outlined in the Coding section, continuing the process of familiarisation with the raw data has enabled a thorough analysis of the qualitative research activities of this project. Generated from the transcripts, the outputs are a series of data charts that show how the first round of coding has come out of the raw data, followed by the identification of summative codes during second-level coding. In some cases I added clarification, which supported the construction of themes. Within this process some potential future directions were identified, which have been outlined in the next chapter. This stage initially led to twelve defined themes (see Table 5), but through re-reviewing the data I removed those that were extraneous or

redundant. For example, ‘individual’ came from the theme construction process, but it was overly explicit when correlating it to the data from the first workshop. Revisiting the raw data, this was in fact my misinterpretation of the participant’s commentary: Jordan was explaining what ‘impetus’ versus ‘initiation’ meant for him when I asked for clarity after an improvisation. I asked, ‘[…]in my head you [are] creating two yous, one dance and one exploration of movement based on those things. Do you see point of initiation versus impetus as different or interchangeable?” (Guérin-Garnett 2022). His reply, ‘they [are] different but they overlap’ (Bridge 2022) clarified this, so I altered my classification. Corroborated by similar occurrences during the workshops, the feedback developed into the wider reaching (and therefore more adapted) theme of impetus/origin instead. It was a similar situation with ‘spontaneity’, ‘sensation’: these were isolated to specific workshop moments, and were better absorbed into the final eight themes.

In line with Braun and Clarke’s reflexive version (2018), this analysis has also been non-linear, continual, and cyclical in nature. The line I have drawn in the sand is not static but vibrant and has resulted in a systemic mapping of themes, which are: honest(y), haptic perception, layers/options (of stimulus), impetus/origin, surprise/unexpectedness, tension/interplay, agency and movement dynamic (see Table 5).

6.8 Summary

Beyond the results discussed at the beginning of this chapter, there were other outcomes that resulted from the methods employed in this research: the external vibrating stimuli placed on the body can produce unexpected results in dance movement; the body is receptive to this stimulus type placed on most musculoskeletal locations, including those beyond the back and abdomen regions; adding further nodes of vibrating stimuli has potential for developing choreographic material; the body-tech prototype can alter movement dynamic in the wearer, and this is a positive user experience; remotely delivered physical stimulus (such as vibration) reduces or eliminates anticipation, resulting in aesthetic tension; uncertainty while anticipating input can produce interesting results; the interplay between participants supports artistry in dance; there is potential for this system design to affect set choreography for new versions and/or language vocabularies, and mixing human and haptic stimulus sources during dance improvisation can deepen the understanding of agency within anthropomorphic-technological relationships.

Following these revelations, and through this reflexive analysis, it became apparent that instruction was at the heart of the information emerging from the practice. And within that, the sending and receiving of instruction is embodied in the choreographic system itself. Rearranging the active agents within this communication is what the experiments examined. Taking instruction from a type of stimulus to initiate movement begins to define some of these agents. But, written as such, this assumes the receiver in the equation – the participant – has no agency within the system. And, demonstrated by these choreographic explorations employing affective technology, this assertion requires nuance. This links to my original

hypothesis that multiple forms of stimulus would confuse a dancer in this setting, and create a negative experience for the user(s). Instead, however, as seen through the verbal feedback, the inverse is generally true: more layers provide more to work with during improvisation. And, importantly, it is the participant who decides what stimulus to follow, which occurred during choreographic sessions without any technology, and with the addition of the vibrating stimulus. These enquiries relate back to those that have been central to this research from the beginning, speculating about the implications of embedding a form of artificial intelligence into the choreographic process.

It is important to note that I have intentionally used 'instruction' in this context to highlight the matter of agency within a creative process that incorporates non-human factors (algorithms in this case) in their construction. However, we must remember that the other key entities within this system are living, thinking biological beings with the capacity for rational thought. They are also artists who have built on years of training and experience to hone their ability to listen to their intuition. While algorithms also make choices, they currently rely on machine learning to digest the information they are given to increase their capacity to 'think', and therefore process more complex decisions. There are intuitive algorithms, but can algorithms mimic human intuition? This conundrum formed the foundation from which I started looking at how the computational machine world engages with the intuitive artistic human world. It prompted me to try and find a way in which this relationship could be symbiotic, or at least less economically imbalanced.

If intuition is loosely described as 'an ability to understand or know something immediately based on our feelings rather than facts' (*Cambridge Advanced Learner's Dictionary & Thesaurus* 2023, para. 1), this might suggest that the human agents developing this choreographic system have done so intuitively. But this would also suggest that they have been ignoring our backgrounds, training and experiences, both past and present. Therefore, I cannot truthfully claim that intuition has been the sole driver of the system design. Instead, I believe it would be more accurate to say the 'why' came from intuition built on instinct, focused through education, and embodied through a life lived; and that the summation of these factors has generated an unwavering need to challenge the current norms within these entwined disciplines.

These questions have also helped support my positioning of these enquiries as artistic research, rather than as other, perhaps more established, forms. Although this project may have used quasi-empirical methods during the tests carried out, these have been planned, executed, digested, and presented to deepen the provocation of these debates and reveal new questions, rather than proposing answers to hypotheses.

Finally, the collaborative choreographic practice I have employed to address my questions may be distilled to a versioned meaning of instruction within the context of a 'human-technology-human' communication system. It can be defined through a vibrating entanglement of where it comes from (impetus/origin), what is given (stimulus type), who gives it (agency), how it is given (haptic perception), how it is followed (honest(y)), how it materialises (movement dynamic), and what it causes

(tension/interplay). The agential collisions have the potential to cause ephemeral moments of surprise/unexpectedness for all those involved. But the difficulty in creating these fleeting micro-performances encourage a desire to predict them, which is something Big Tech-led artificial intelligence is striving to master.

7 CONCLUSION

7.1 Revisiting the Arguments

This research originally set out to increase the awareness and understanding of the potential effects of artificially intelligent digital technologies using dance choreography, and in so doing, consider how this creative process could illuminate some of the impacts of AI on our bodies. Following that line of inquiry, this study also looked at the ways in which digital data could be translated into physically tangible sensations, and how this process might feel for the research participants involved. Recalling the research aims, using my embodied knowledge and awareness of other bodies I built a body-tech apparatus that could receive remotely sent information and translate it into sequences of vibration to influence dance improvisations in the wearer. The results of this digitally-aided choreographic system produced new choreographic material, enabling the dancer-participants and me to learn from the experience, and version the body-tech exoskeleton. I compiled their responses, combined with my own, contextualised them through relevant parallel voices in this area, and synthesised this information into data reports, which evolved into the material to compose this thesis text.

Through this extensive process I am now able to argue:

1. That dance is well positioned as a medium to investigate the potential physical effects of AI technologies on our bodies;
2. That contemporary dance choreography viewed as a creative process may alter our perspective on AI, thereby raising questions about its drivers: who is promoting/encouraging these advances, and why; and
3. That dance may help address the issue of the increasing use of human gait recognition equipment that can capture our biometric data without our knowledge or consent.

7.2 New Understanding

Machinatia has not yet integrated a digital algorithm, advisory or performative, in its list of components. However, through it I have demonstrated how the main output of this research, the choreographic system dissected and explained in this thesis and shown via the associated integral material, is poised for this next step. Through a physical computing-enabled body-tech prototype, I showed how choreographic instructions can be transmitted by pressing a button to manifest into digital data sent wirelessly through space with Bluetooth technology. Also, that this invisible information can be transformed through a microcomputer connected to a buzzing pager motor embedded in a dance costume to materialise as pulsations for the wearer to interpret through movement improvisations. The participants involved in the process carried out for the development of this choreographic system also reported a positive user experience during the practice-based research of *Machinatia*. Their verbal, written and physical responses informed the shape, material choices, finishes and overall construction of the wearable devices, ultimately

placing the participants at the centre of the prototype development, and helping to address the aim of this research with respect to technological developments.

I created a connection between a human decision-maker (myself or one of the dancers) and another human physical interpreter (the other dancer participant) remotely through the feeling sensation of vibration on their bodies. This process facilitated the sending and receiving of non-lingual/verbal information to instigate improvisational movement, thereby creating an illustrative method for this model of a choreographic system. By isolating these different system nodes/points I demonstrated how they can interlink through a choreographic context that transcends both analogue and computationally-based data. We already understand that artificial intelligence is trained on and processes this type of data using computers (ChatGPT uses GPUs instead of CPUs,[66] for example): therefore, extending this reality via the system design developed in this research is likely to be technologically feasible. With this additional channel formed, it then becomes possible to consider what might happen if the decision-maker in this scenario was artificially intelligent, versus biologically human. A rudimentary framework for expanding our knowledge into the possibilities of being physically touched, or impacted by, decisions that an AI may make has consequently been sketched out.

So, what new things do we know? We now have a better understanding about integrating a digitally supported apparatus into choreography that physically influences the body's movement, through a process that does not employ avatars or other visualisations to affect the choreographic process and develop new movement material. We now know that this system could be adapted for use in dance training or choreography to change movement dynamics in dancers. And we now have an architecture primed for integrating an AI in the creative decision-making process, which may then be applied outside dance choreography to other mediums.

Ultimately, this research did raise new questions. Realised through the choreographic practice, questions were asked about what might happen if we increased the strength of the buzzing vibration. And what might happen if we changed the type of stimulus to something other than vibrations. What would happen if a performative algorithm was used that could direct these two variables? Where else might this set-up be applied, and would these other contexts generate positive user experiences, or facilitate risk? Therefore, while this thesis exists within academia and an artistic context, the potential for its outcomes to be negatively manipulated should not be ignored. Raising awareness of these risks therein exemplifies the rationale behind this project, if for no other reason than to help to ensure that AI advances and their deployment are kept in check.

[66] Graphics processing unit and central processing unit.

7.2 Contribution

In its current guise, the choreographic system design proposes that the decisions of vibrating sequencing being sent were advisory, because ultimately the receiver still owns the decision about how to respond. The resulting architecture of this system presented a way for the decisions of what vibrating instructions could in fact be decided upon by an intelligent agent, such as a learning algorithm or more advanced form of artificial intelligence. Following this dynamic, this research contributes a novel choreographic method, whereby its system construction is a framework for enabling the integration of algorithms, including those run by AI, within a creative process, within which both human and AI actors may have presence and agency.

Although the vibrating sequences in the choreographic practice in this research were not decided by an algorithm, the system structure is composed for such an intervention. Its communication process emphasised the importance of each agent, showing that already there is much to be learned from these experiments, even before any algorithmic affects. This study has proposed examples that enable society more effectively to hand over decision-making power to a non-biologically human intelligence within and beyond artistic pursuits.

This research generated a system design that presents a way of communicating physical sensation through digital technologies. Its performance posits new knowledge via its novel method of manifesting digital data in the physical world through its remote vibrating body-tech apparatus design. Consequently, this makes an original contribution to scholarship in the fields of performance and new media, dance choreography, and digital fashion creation.

7.3 Benefits

Referring back to the introductory note about Voice seeking to reach a wider, also non-academic audience, I refer again to Mark Edward, who has taken a similar stance with his thesis, stating:

> I set out my me/thods […] ensuring that they moved beyond academic engagement and were accessible to wider audiences through the use of a more accessible term. My concern is the reach and impact of my creative practice-led work to non-academic audiences, and this is where the term mesearch and my courting the poetic with the personal seeks to fill that lacuna,' (Edwards 2018, p.96).

I have tried to mimic some of his approach, as also set out in the preamble (see Voice on page 11), by using the less formal tone of academic writing I have chosen for this text. I believe the topic of the rapidly increasing deployment of AI technologies is both pressing and pertinent for contemporary society. And for this reason, I hope the arguments communicated here are useful for researchers and other academics at all levels, particularly those working at the intersection of creativity and digital technology. It is also not only because of my fashion and dance industry background that I want people outside academic circles to engage with this work. It is also because those workforces and creatives have evolved over the last few

decades, many of them migrating towards Big Tech companies and/or their subsidiaries around the world. My hope is that they benefit from the perhaps unusual path I have travelled, hopefully to find ways of applying their skillsets in improving the lives of others, and not only the shareholders of their employers. Other technology companies trying to understand human needs to build trust in their products, and/or develop them through methods that genuinely place human well-being at their centre, may also glean from this research. Within the performing arts, the research and future renditions of my body-tech prototype will ideally help contemporary dancers develop their artistry through movement, correct their technique, or try unfamiliar stylistic dynamics. More generally, this work may also be relevant to artists and designers who create in digital spaces and want to physically experience/engage with their material creations in the real world.

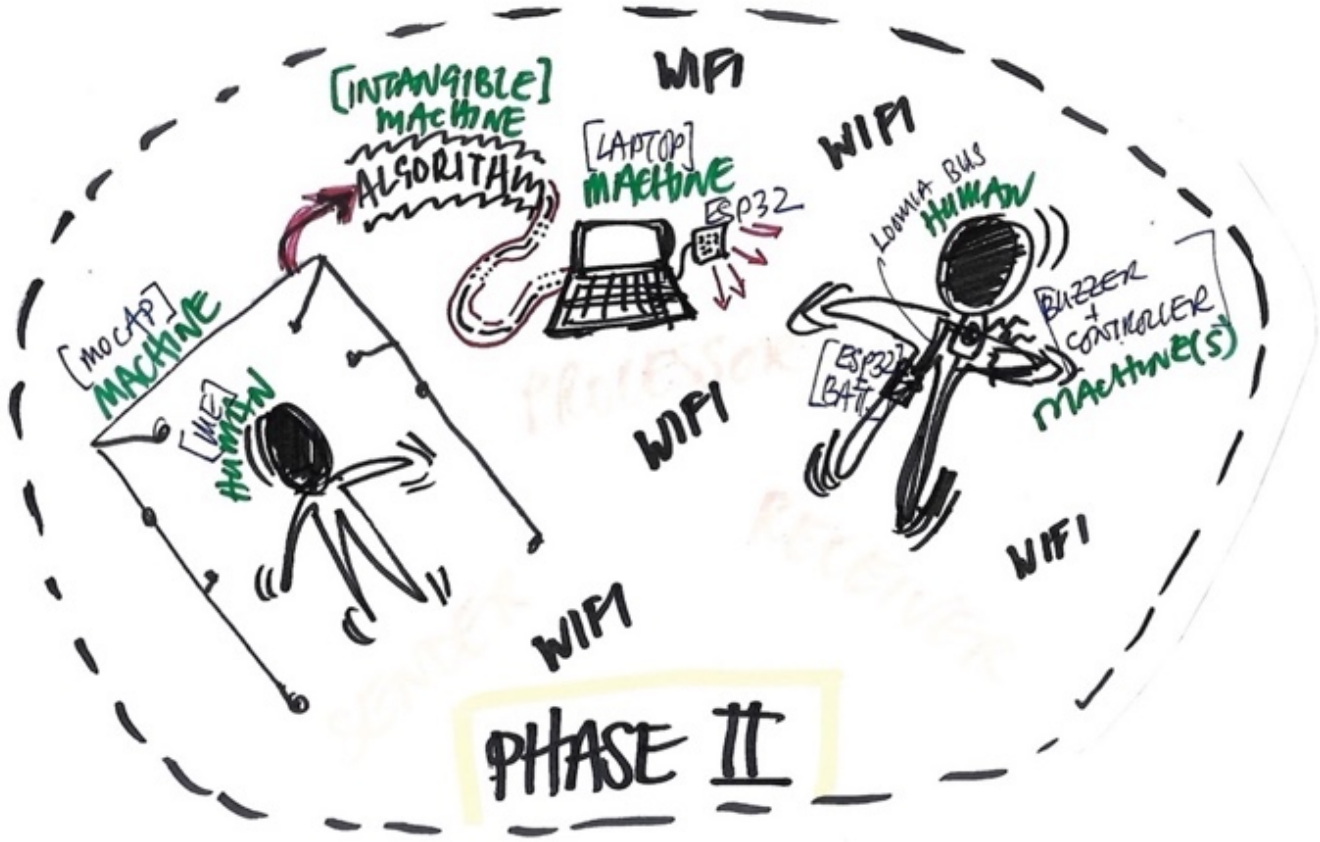


Figure 47: Sketch of Phase II of this research (Guérin-Garnett 2022).

7.4 *Machinatia II*: Further Research

Despite navigating a global pandemic for a significant portion of this research, its planning and delivery has been an enriching experience. And while this period of discovery may help to develop an emerging discipline, I have only begun to scratch the surface. In the section about building a remote vibrating apparatus I briefly referred to this PhD as Phase I, and indicated that the next would be included here. As proof, I have included the equally rough sketch of Phase II (Figure 48) which has been part of my plan since the inception of the research. As envisaged, this would involve building a digital/computer-processed algorithm that would replace the button in the existing system design. This learning algorithm

would form part of an artificial intelligence that has been trained on my choreographic data, captured via MoCap. I would like to use the second phase of my system to explore how the AI could recognise the source of material, and to what level of accuracy. I suggest that such an investigation could have significant impact, and help foster a (more) balanced symbiotic relationship with AI in creative processes.

In the final stages of completing this thesis, the extended aims of my future research mentioned above have been ratified by some of the artists working at the cutting edge of AI and digital technology developments through their practices, such as Marco Donnamurra and Stocos (mentioned in Section 3.5 on page 60). In parallel, it is encouraging to see research taking place that will use dance to provide the context to address agency in today's world. Anna Macdonald, for example, recently secured UK research council[67] funding for *The Choreography of Consent: experiments in dance/law research* for a two-year project looking at the ways in which dance-based research may expand our understanding of consent as one prong of inquiry (Jacob and Macdonald 2024). Linking the notion of consent through legal frameworks could take place along similar lines of interrogating agency in creative decision-making processes, also using dance as the context through which achieve a rebalance by reprioritising the human body over capital expansion.

7.5 Dance as Resistance

If I think back to the initiation of this project, I cannot help but feel it in my own body, because it actually originated from discovering my own Graham contraction all those years ago. It took time and practice to find, but once achieved it never really left, instead residing therein for decades, only to resurface as the source of the irreplicable way I move. I can now say that with sufficient confidence, thanks to this doctoral journey imbued with the embodied knowledge I had acquired beforehand. I can also now say that this unique experience lies not only in me, but in others too, because this is what I learned from my research participants, contextual investigations, and reflexive processes. Finding the contraction is a deeply personal thing, not just because its kinesiology occurs deep inside the body, but also because it remains elusive until you unearth the truth in your movements. Only then can you begin to understand your unique movement signature, a fleeting moment that would be challenging for technology to measure. Learning algorithms and AI process human morphology using median-based sets of data, but there is nothing average about finding, feeling, understanding, practising, and performing your very own contraction. This presents hope for humanity in that it retains a degree of agency in spite of the tsunami of digital technology designed to digitise our collective corporeality. To the ever-growing stable of Big Tech organisations, I say this: we will always dance like no one is watching, even if your bionic eyes pretend to be like us.

[67] From the Arts and Humanities Research Council (AHRC), this project is set to commence in September 2024.

REFERENCES

Primary Sources

Bridge, J.J. and Guérin-Garnett, N. 2022. Interviews: Sessions 1 and 2 Choreographic Workshops

Gerber Davis, L. and Guérin-Garnett, N. 2019. Online discussion on the role of data (in experiments and my research). [FaceBook chat] 13 April.

Muir, E. and Guérin-Garnett, N. 2022. Interviews: Session 2 Choreographic Workshops.

Sicchio, K. and Guérin-Garnett, N. 2019. Interview [Skype].

Published Material

Abbatemarco, M. A. I. 2020. Gait analyser and wearable movement sensing device. *Hackster*. Available at: https://www.hackster.io/mhanuel/gait-analyser-and-wearable-movement-sensing-device-8f5048#story. [Accessed 19 July 2022].

About Johannes Birringer. 2020. *Intellect Books*. Available at: https://www.intellectbooks.com/johannes-birringer. [Accessed 21 August 2020].

Aghakouchak, A. n.d. Performance. *Ava Aghakouchak*. Available at: https://www.avakouchak.co.uk/performance (Accessed: July 19, 2022).

Akins, T. 2016. Vigenère (Web-based tools: ciphers and codes). *Rumkin.* Available at: https://rumkin.com/tools/cipher/vigenere/ (Accessed: 16 February 2023).

Angwin, J. et al. 2016. Machine bias: there's software used across the country to predict future criminals. And it's biased against Blacks. *ProPublica.* Available at: https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing. [Accessed 3 January 2023].

Askr, H. et al. 2023. The future of Metaverse in the virtual era and physical world: analysis and applications. *Studies in Big Data*. 123, pp. 59–75. doi:10.1007/978-3-031-29132-6_4.

Aubrecht, J.F. 2017. Choreographers and yogis: untwisting the politics of appropriation and representation in U.S. concert dance. Ph.D. thesis, University of California Riverside.

Baker, C. 2022. Demonstrating the choreographic system. In *Extended Senses & Embodying Technology Symposium*, University of Greenwich, London, 8-9 September. Available from: https://www.extendedsenses22.co.uk/

Bannerman, H. 1999. An overview of the development of Martha Graham's movement system (1926-1991). *Dance Research: The Journal of the Society for Dance Research*, 17(2), pp. 36-28.

Bannerman, H. 2014. Is dance a language? Movement, meaning and communication. *Dance Research: The Journal of the Society for Dance Research*. 32(1), pp. 65-80.

Benaich, N. and Hogarth, I. 2022. *State of AI Report*. Available at: https://www.stateof.ai/ [Accessed 9 January 2023]. Page 95-106.

Benbasat, I., Jussupow, E. and Heinzl, A. 2020. Why are we averse towards algorithms? A comprehensive literature review on algorithm aversion. *28th European Conference on Information Systems - A Virtual AIS Conference.* Marrakech, June 2020. Marrakech: Association for Information Systems, 4.

Blom, L.A. and Chaplin, L.T. 1988. *The moment of movement: dance improvisation*. Pittsburgh, PA: University of Pittsburgh Press.

Bobick, A. et al. 2005. Human identification at a distance. *Georgia Tech GVU Center College of Computing.* Available at: https://www.cc.gatech.edu/cpl/projects/hid/. [Accessed 8 January 2023].

Bostrom, N. and Yudkosky, E. 2014. The ethics of artificial intelligence. In Frankish, K. and Ramsey, W. (ed.) *Cambridge handbook of artificial intelligence.* New York: Cambridge University Press, pp. 1-3; 317-323.

Braun V. and Clarke V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2), pp. 79. Available at: http://dx.doi.org/10.1191/1478088706qp063oa.

Braun, V., Clarke, V., Hayfield, N. and Terry, G. 2018. Thematic analysis. In *Handbook of research methods in health social sciences*, p. 6. https://doi.org/10.1007/978-981-10-2779-6_1-18 [Accessed 22 November 2022].

Burrows, J. and Hayward-Smith, L. 2021. Hetty Blades - a way of paying attention. *Inventing Embodiment* [Podcast]. Available at: https://soundcloud.com/user-235484908/sets/inventing-embodiment [Accessed: 12 June 2023].

Design and Performance Lab. 2019. *Brunel University*. Available at: https://www.brunel.ac.uk/dap. [Accessed 21 August 2020].

Candy, L. 2006. Practice-based research: a guide. *Creativity & Cognition Studios Report* 1.

Intuition. 2023. *Cambridge Advanced Learner's Dictionary & Thesaurus*. Available at: https://dictionary.cambridge.org/dictionary/english/intuition. [Accessed 8 January 2023].

Centres for Disease Control and Prevention. 2021. *The AIDS epidemic in the United States, 1981- early 1990s*. Available at: https://www.cdc.gov/museum/online/story-of-cdc/aids/index.html. [Accessed 22 January 2022].

Checkland, P. 1999. Systems thinking. In W. Currie and B. Galliers (eds.) *Rethinking management information systems: an interdisciplinary perspective*. 2nd edn. New York, NY: Oxford University Press, pp. 45–45.

Crnkovic-Friis, L. and Crnkovic-Friis, L. 2016. Generative choreography using deep learning. In *Proceedings of the Seventh International Conference on Computational Creativity,* p. 123.

Crooks, M. 2022. Oct 4, 1957 CE: USSR launches Sputnik. *National Geographic.* Available at: https://education.nationalgeographic.org/resource/ussr-launches-sputnik. [Accessed 8 January 2023].

Dall·E now available in beta. 2022. *OpenAI*. Available at: https://openai.com/blog/dall-e-now-available-in-beta (Accessed: 10 August 2023).

DARPA. n.d. About DARPA. *Defense Advanced Research Projects Agency*. Available at: https://www.darpa.mil/about-us/about-darpa. [Accessed 8 January 2023].

Design Council. 2004. Seven tenets of human-centred design. (Our Resources). *Design Council.* Available at: https://www.designcouncil.org.uk/our-resources/seven-tenets-of-human-centred-design/ (Accessed: 11 August 2023).

De Stefano, V. 2019. "Negotiating the algorithm": automation, artificial intelligence and labour protection. *Comparative Labor Law & Policy Journal* 41.1. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3178233 [Accessed 8 January 2023].

Devolution. n.d. *Australian Dance Theatre*. Available at: https://adt.org.au/works/devolution/ (Accessed: July 19, 2022).

Dixon, S. J. 2023. Countries with the most Facebook users 2023 (Leading countries based on Facebook audience size as of January 2023). *Statista*. Available at: https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/. [Accessed 17 February 2022].

Edward, M. 2018. *Mesearch and the performing body*. Cham, Switzerland: Palgrave Pivot.

Elger, D. 2002. *Expressionism: a revolution in Germany*. 2nd. edn, trans. by Hugh Beyer, Cologne: Taschen.

Erisman, P. 2017*. Six billion shoppers: the companies winning the global e-commerce boom*, New York: St. Martin's Press.

Excell, J. 2012. NPL takes step forward with Gait Recognition System, Defence & Security. *The Engineer*, 1 September. Available at: https://www.theengineer.co.uk/npl-takes-step-forward-with-gait-recognition-system/ (Accessed: 24 January 2022).

Ferreira, J., Fernandes, C., Rammal, H. and Velga, P. 2021. Wearable technology and consumer Interaction: A systematic review and research agenda'. *Computers in Human Behavior* 118(3), pp. 106710.

Fox, S., McAllum, K., Simpson, and M. Unson, C. 2019. A comparative tale of two methods: how thematic and narrative analyses author the data story differently. *Communication Research and Practice* 5.4, pp. 358-375. https://doi.org/10.1080/22041451.2019.1677068.

Gao, F., Tian, T., Yao, T. and Zhang, Q. 2021. Human gait recognition based on multiple feature combination and parameter optimization algorithms. *Computational Intelligence and Neuroscience*. Article 6693206. Available at: https://doi.org/10.1155/2021/6693206 [Accessed 24 January 2022].

Glanville, R. 2013. Cybernetics thinking through the technology. In: D. Arnold, ed., *Traditions of systems theory*. New York: Routledge.

Haenlein, M. and Kaplan, A. 2019. A brief history of artificial intelligence: on the past, present, and future of artificial intelligence. *California Management Review* 61.4. https://doi.org/10.1177/0008125619864925 [Accessed 3 January 2023].

Hand, J. and Lev, B. 2003*. Intangible assets*. 2nd ed. Oxford: Oxford University Press.

Heaven, W.D. 2023. The inside story of how ChatGPT was built from the people who made it. *MIT Technology Review* (Artificial Intelligence). Available at: https://www.technologyreview.com/2023/03/03/1069311/inside-story-oral-history-how-chatgpt-built-openai/ (Accessed: 10 August 2023).

Human Rights Campaign. 2021. *Blood donations*. Available at: https://www.hrc.org/resources/blood-donations. [Accessed 22 January 2022].

Informa PLC. 2022. *IFSEC Global.* Available at: https://www.ifsecglobal.com/. [Accessed 22 January 2022].

Ismail, K. and Krishnan, N.,2018. AI vs. algorithms: what's the difference? *CMSWIRE*. Available at: https://www.cmswire.com/information-management/ai-vs-algorithms-whats-the-difference/. [Accessed 3 January 2023].

Janbi, N., Katib, I. and Mehmood, R. 2023. Distributed artificial intelligence: taxonomy, review, framework, and reference architecture. *Intelligent Systems with Applications*, 18. doi:10.1016/j.iswa.2023.200231.

Jones, J. 2021. LGBT identification rises to 5.6% in latest U.S. estimate. *Gallup.* Available at: https://news.gallup.com/poll/329708/lgbt-identification-rises-latest-estimate.aspx. [Accessed 25 January 2022].

Kamei, J. et al. n.d. WIM haptic dress for dancers' *Junkamei.* Available at: http://www.junkamei.com/work#/wim-1/ (Accessed: July 19, 2022).

King, M.R. and ChatGPT. 2023. A conversation on artificial intelligence, chatbots, and plagiarism in higher education. *Cellular and Molecular Bioengineering* 16 (1), pp. 1–2. doi:10.1007/s12195-022-00754-8.

Kirkpatrick, K., 2020. Who has access to your smartphone data? *Communications of the ACM.* 63 (10), pp. 16-17. Available at: https://cacm.acm.org/magazines/2020/10/247585-who-has-access-to-your-smartphone-data/fulltext [Accessed 22 January 2022].

Klosowski, T. 2020. Facial recognition is everywhere. Here's what we can do about it. *The New York Times* (*Wirecutter*) 15 July. Available at: https://www.nytimes.com/wirecutter/blog/how-facial-recognition-works/. [Accessed 17 February 2022].

Kraus, S, Kanbach, D, Krysta, P and Steinhoff, M. 2022. Facebook and the creation of the Metaverse: Radical business model innovation or incremental transformation? *International Journal of Entrepreneurial Behaviour & Research* 28(9).

Kroenung, T. 2020. *Momentaufnahmen*: building a feminist method of contemporary fashion analysis through the translation of Helen Grund's texts. Ph.D. thesis, Royal College of Art.

Kumar Gupta, S. and Chattopadhyay, P. 2021. Gait recognition in the presence of co-variate conditions. *Neurocomputing* 454, pp. 76-87. Available at: https://doi.org/10.1016/j.neucom.2021.04.113 [Accessed 24 January 2022].

Kurzweil, R. 1999. *The age of spiritual machines: when computers exceed human Intelligence*. New York, NY: Penguin Books.

Lanier, J. 2014. *Who owns the future?* London: Penguin Books.

Leach, J. and deLahunta, S. 2017. Dance becoming knowledge: Designing a digital "body". *Leonardo*, 50.5, pp. 461-467. doi:10.1162/leon_a_01074.

Lee, D. 2018. A deal with the devil? Insights on Google's AI patents. Artificial intelligence & software, *PI IP Law*, 19 November. Available at: https://piip.co.kr/en/blog/google-patents-open-source-software-1. [Accessed 9 January 2023].

McCorduck, P., Minsky, M., Selfridge, O. and Simon, H.A. 1977. History of artificial Intelligence. In *Proceedings of the 5th International Joint Conference on Artificial intelligence*, IJCAI'77. Cambridge Massachusetts, USA, 22 August 1977. Cambridge, MA: MIT Press, 953-954.

McGregor, L., Murray, D. and Ng, V. 2019. International human rights law as a framework for algorithmic accountability. *International and Comparative Law Quarterly* 68 (2), pp. 309-343. Available at: https://doi.org/10.1017/S0020589319000046 [Accessed 14 December 2022].

McMullan, T. 2019. This outfit can help deaf people feel music. *OneZero*. Available at: https://onezero.medium.com/this-outfit-can-make-deaf-people-feel-music-d0df553efa97. [Accessed 23 August 2020].

Martha Graham Center of Contemporary Dance, Inc., n.d. History. *Martha Graham.* Available at: https://marthagraham.org/history/. [Accessed 2 September 2020].

Martha Graham reflects on her art and a life in dance. 1985. *The New York Times*, 31 March, Section 2,1.

Mehrabi, N. et al. 2021. A survey on bias and fairness in machine learning. AC*M Computing Surveys* 54(6), Article 115. Available at: https://doi.org/10.1145/3457607.

Mori, E. and Edmonds, E. 2023. Professor Ernest Edmonds. *Archivesit*. Available at: https://archivesit.org.uk/interviews/professor-ernest-edmonds/ (Accessed: 12 June 2023), pp. 18-19 (PDF download).

OpenAI, Available at: https://openai.com/ (Accessed: 10 August 2023).

OptiTrack, 2019. *Motion capture systems*. *DBA OptiTrack*. Available at: https://optitrack.com/ (Accessed: 27 March 2019).

Owen, N. and Gay, P. (eds.) 2018. *Nederlands Dance Theater III: Evergreens*, Dance Interactive, Jacob's Pillow. Available at: https://danceinteractive.jacobspillow.org/nederlands-dance-theatre-3/evergreens/ [Accessed: 30 July 2024].

Paikin, S. and Lanier, J. 2013. *Jaron Lanier: who owns the future*? [Youtube video]. Toronto, Ontario: TVO.

Palacio, P. and Romero, M. 2022. Embodied machine. *Instituto Stocos*. Available at: https://www.stocos.com/en/page/embodied-machine-2/ (Accessed: 17 July 2024).

Parker-Starbuck, J. and Mock, R. 2011. Researching the Body in/as Performance. In *Research methods in theatre and performance*. Edinburgh: Edinburgh University Press, pp. 210-235. https://doi.org/10.1515/9780748646081-012

Politis, G. 1990. Computers and dance: a bibliography. *Leonardo*, 23(1), pp. 87-90.

Powers, M. 2001. Applying a constructivist pedagogy to design studio education. *ARCC Spring Research Conference*. Blacksburg, 8-10 April 2001. Blacksburg: Virginia Polytechnic Institute and State University – College of Architecture & Urban Studies, pp. 77-83.

Quarini, C.A. 2019.The domestic veil: Exploring the net curtain through the uncanny and the gothic. *Textile: Cloth and Culture* 18(3), pp. 232-249

Ravenscroft, E. 2023. What is the Metaverse, exactly? *Wired*, 15 June. Available at: https://www.wired.com/story/what-is-the-metaverse/. [Accessed 8 January 2023].

Reed Doob, P.B. 2013. Karen Kain, *Historica Canada*, 11 June. Available at: https://www.thecanadianencyclopedia.ca/en/article/karen-kain. [Accessed 30 July 2024].

Rees, K. 2022. Improvising with digital touch. *Multimodality & Society*, 2(3), pp. 247–260. doi:10.1177/26349795221111279.

Rees, K., 2022. Somatosensory wearable technology in the dance making process: Investigating digital touch in the formation of Creative Movement and Kinaesthetic Awareness*.* Ph.D. thesis, University of the Arts London. Available at: https://ualresearchonline.arts.ac.uk/id/eprint/19921/. [Accessed: 17 July 2024].

Reynolds, D. 2002. A technique for power: reconfiguring economies of energy in Martha Graham's early work. *Dance Research*, 20(1), pp. 3–32. doi:10.3366/1290867.

Reuters staff, 2011. U.S. tests Bin Laden's DNA, used facial ID: official. *Reuters*, 2 May. Available at: https://www.reuters.com/article/us-binladen-dna/u-s-tests-bin-ladens-dna-used-facial-id-official-idUSTRE7411HJ20110502. [Accessed 17 February 2022].

Robb, D. 2022. AI vs. algorithms.. *eWeek*. Available at: https://www.eweek.com/big-data-and-analytics/ai-vs-algorithms/. [Accessed 3 January 2023].

Roulston, K. 2020. Analysing interviews. in Flick, U. (ed.) *SAGE handbook of qualitative data analysis*. London; Thousand Oaks, CA: SAGE, 297-312.

Ryan, M. 2020. In AI we trust: ethics, artificial intelligence, and reliability. In *Science and Engineering Ethics* 26, pp. 2749-2767. Available at: https://link.springer.com/article/10.1007/s11948-020-00228-y [Accessed 8 January 2023].

Sagasti, F. 2019*.* Information technology and the arts: the evolution of computer choreography during the last half century. *Dance Chronicle*, 42(1), pp. 1-52.

Satomi, M. 2020-. Dancing at the edge of the world. *Nerding*. Available at: https://www.nerding.at/costume-for-dancing-at-the-edge-of-the-world/ (Accessed: July 19, 2022).

Schiphorst, T. 1986. A case study of Merce Cunningham's use of the LifeForms computer choreographic system in making of *Trackers*, MA thesis, Simon Fraser University, Burnaby, Canada.

Sheridan, T. and Verplank, W. 1978. *Human and computer control of undersea teleoperators.* Report NR 196-152, Massachusetts Institute of Technology Engineering Psychology Programs, Office of Naval Research. Arlington.

Simmons, G.J. 1999. Vigenère ciphers, Cryptology. *Britannica*. Available at: https://www.britannica.com/topic/cryptology/Vigenere-ciphers (Accessed: 13 February 2023).

Skains, R.L. 2018. Creative practice as research: Discourse on methodology. *Journal of Media Practice and Education*, 19(1), 82-97. doi:10.1080/14682753.2017.1362175.

Studio Wayne McGregor, n.d. *Wayne McGregor*. Available at: https://waynemcgregor.com/about/wayne-mcgregor (Accessed: July 19, 2022).

Sullivan, G. 2010. *Art practice as research: inquiry in the visual arts*. 2nd edn. Los Angeles, CA: Sage.

Surveillance. 2021. *Politics.co.uk* Available at: https://www.politics.co.uk/reference/cctv/. [Accessed 22 January 2022].

Turing, A. 1950. Computing machinery and intelligence. *Mind,* 49(236), pp. 433-460.

Vaismoradi, M., Jones, J., Turunen, H. and Snelgrove, S. 2015. Theme development in qualitative content analysis and thematic analysis. *Journal of Nursing Education and Practice* 6(5), pp. 100-110. Available at: http://dx.doi.org/10.5430/jnep.v6n5p100 [Accessed 22 November 2022].

Van der Maaten, L. and Hinton, G. 2008. Visualizing data using t-SNE. *Journal of Machine Learning Research* 9(2579-2605), Available at: https://www.jmlr.org/papers/volume9/vandermaaten08a/vandermaaten08a.pdf [Accessed 11 June 2019].

Vigenère cipher, cryptography, modern Nostradamus interpretation. 2010. *Nostradamus Wiki.* Available at: https://nostradamus.fandom.com/wiki/Vigen%C3%A8re_cipher (Accessed: 13 February 2023).

Vinge, V. 1993. The coming technological singularity: how to survive in the post-human era. In *VISION-21 Symposium*, NASA Conference Publication. Cleveland, OH: NASA 11-22.

Von Glasersfeld, E. 1996. Aspects of radical constructivism. In Pakman, M. (ed.) *Construcciones de la experiencia humana.* Barcelona: Gedisa Editorial,pp. 200-201.

Wieringa, M. 2020. What to account for when accounting for algorithms: A systematic literature review on algorithmic accountability. In *Conference on Fairness, Accountability, and Transparency (FAT* '20),* January 27–30, 2020, Barcelona. New York, NY: ACM, pp.100-110. https://doi.org/10.1145/3351095.3372833.

Williams, M. 2021. Facebook diversity update: Increasing representation in our workforce and supporting minority-owned businesses. *Meta,* 15 July. Available at: https://about.fb.com/news/2021/07/facebook-diversity-report-2021/ (Accessed: 25 January 2022).

Wilshaw, P. 2018. Putting AI into a black-box of super-ethics. (Imagining the future with machine learning). *Towards AI*, 5 January. Available at: https://pub.towardsai.net/putting-ai-into-a-black-box-of-superethics-893d1333090e. [Accessed 9 January 2023].

Zuckerberg, M. 2021. Exhibit 3.1: Facebook, Inc. Amended & Restated Certificate of Incorporation, Exhibit A: Meta Platforms, Inc. Amended & Restated Certificate of Incorporation. *Securities and Exchange Commission*. Available at: https://www.sec.gov/Archives/edgar/data/1326801/000132680121000071/a20211028-exhibit31.htm#:~:text=The%20name%20of%20the%20corporation%20is%20Meta%20Platforms%2C%20Inc.&text=The%20address%20of%20the%20corporation's,%2C%20New%20Castle%20County%2C%19808. (Accessed: January 22, 2022).

Figures & Tables

Anyoha, R. 2017. The History of Artificial Intelligence. *Harvard University, Graduate School of Arts and Sciences, SITN* (*Science in the News*). Available at: https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/ [Accessed 9 January 2023].

Dörr, E. and Lantz, L. 2003. Rudolf von Laban: the “Founding Father” of Expressionist Dance. *Dance Chronicle,* 26(1), pp. 1-29.

Edward, M. 2018. Diagram to demonstrate the relationship between autoethnography, mesearch and performance, *Proquest Ebook Central*. Springer International Publishing AG. Available at: https://ebookcentral.proquest.com/lib/rcauk/detail.action?docID=5240707 (Accessed: 16 July 2024).

Fraser, C. 2010. Ballet room corners: Cechetti, RAD & Russian / Vaganova. *The Dance Buzz.* Available at: http://thedancebuzz.blogspot.com/2010/11/ballet-room-corners-cechetti-rad.html. [Accessed 13 February 2023].

GeeksforGeeks. 2023. The "standard interpretation" of the Turing Test. *Geeks for Geeks.* Available at: https://www.geeksforgeeks.org/turing-test-artificial-intelligence/ [Accessed 9 January 2023].

Grant, G. 1967. Basic positions of the body: Cecchetti method. In *Technical manual and dictionary of classical ballet.* 2nd edn. Mineola, NY: Dover Publications, pp. 122-123.

Guérin-Garnett, N. 2016. *344|142.* Performed London, The Vinyl Factory: Nigel Guérin-Garnett. Performance: Dance. (viewed 15 September 2016).

Guérin-Garnett, N. 2016. *List of creative process steps to design with algorithms* at Kingston School of Art, London.

Guérin-Garnett, N. 2016. *Six phrases* at Kingston School of Art, London.

Guérin-Garnett, N. 2016. *Sketches of polygon silhouettes* at Kingston School of Art, London.

Guérin-Garnett, N. 2016. *WoW project submission: realised 3D garment* at Kingston School of Art, London.

Guérin-Garnett, N. 2016. *WoW project visualised research* at Kingston School of Art, London.

Guérin-Garnett, N. 2017. *344|142*, *Artwork*. Available at: https://artrepreneur.com/portfolio/APHreghCxsMmiKwpf (Accessed: 16 February 2023).

Guérin-Garnett, N. 2018. *Leather prototypes with thonging* at the Royal College of Art. London.

Guérin-Garnett, N. 2018. *Testing vibrating stimulus* at the Royal College of Art. London.

Guérin-Garnett, N. 2018. *Trembling structure, smaller leather prototypes* at the Royal College of Art. London.

Guérin-Garnett, N. 2019. *3D scanning techniques* at the Royal College of Art. London.

Guérin-Garnett, N. 2019. *Capturing a tendu with digital imagery* at the Royal College of Art. London.

Guérin-Garnett, N. 2019. *Digitising the tendu* at the Royal College of Art. London.

Guérin-Garnett, N. 2019. *Rokoko suit and OptiTrack MoCap system* at the Royal College of Art. London.

Guérin-Garnett, N. 2019. *Visualising the body captured with MoCap technology* at the Royal College of Art. London.

Guérin-Garnett, N. 2020. *Phase I choreographic system sketch* at the Royal College of Art. London.

Guérin-Garnett, N. 2020. *Phase II choreographic system sketch* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Button set-up, microcomputer and battery* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Circuit diagram for the portable node* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Eileih and Jordan performing Pulse* at Studio Wayne McGregor. London.

Guérin-Garnett, N. 2022. *Eileih performing phrase wearing apparatus* at Studio Wayne McGregor. London.

Guérin-Garnett, N. 2022. *First elastic harness prototype* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Jordan's first responses to vibrating prototype* at Studio Wayne McGregor. London.

Guérin-Garnett, N. 2022. *Jordan performing pre-formed phrase* at Studio Wayne McGregor. London.

Guérin-Garnett, N. 2022. *Movable vibrating motor mounted on elastic* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Portable node mount and power source* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Power source and electronics mounted in garment* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. Second *elastic harness prototype* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Second elastic harness prototype with electronics* at the Royal College of Art. London.

Guérin-Garnett. 2022. *Session 1 and 2 Choreographic Workshops - Interviews.* Discourse with Bridge, J.J. and Muir, E. for this PhD thesis.

Guérin-Garnett, N. 2022. *Stationary node* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Testing 3V battery vibrations* at the Royal College of Art. London.

Guérin-Garnett, N. 2022. *Transferring controls to Eileih to try* at Studio Wayne McGregor. London.

Guérin-Garnett, N. 2022. *Vibrating ring programming on iPhone* at the Royal College of Art. London.

Guérin-Garnett, N. 2023. *Coding and clustering progression*, table for this thesis at the Royal College of Art. London.

Guérin-Garnett, N. 2023. *Rounds of thematic development,* for this thesis at the Royal College of Art. London.

Kleida, D. 2018. On the technological conditions of the representation of movement: dance notation systems & annotation practices as gestures. Master's thesis, Utrecht University.

Oxenham, A. 1979. Artists of The Toronto Dance Theatre in its Production of Seastill. *Toronto Dance Theatre*. [Image] Available at: <https://tdt.org/1978-1987> [Accessed 3 September 2020].

Parasuraman, R., Sheridan, T. and Wickens, C. 2000. A model for types and levels of human interaction with automation. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 30(3), pp. 286-297.

Petrikovic, G. 2022. *Fitting first elastic prototype* at Studio Wayne McGregor. London.

Petrikovic, G. 2022. *Jordan trialling Pulse variaitons* at Studio Wayne McGregor. London.

Petrikovic, G. 2022. *Teaching Jordan Pulse* at Studio Wayne McGregor. London.

Petrikovic, G. 2022. *Terms used to generate phrases* at Studio Wayne McGregor. London.

Sheridan, T. and Verplank, W. 1978. *Human and computer control of undersea teleoperators.* Report NR 196-152, Massachusetts Institute of Technology Engineering Psychology Programs, Office of Naval Research. Arlington.

Sobol, E. 1926. Rudolph von Laban, originally published in *Geschichte des Tanzes*, reproduced from Dianne S. Howe, *Individuality and Expression: The Aesthetics of the New German Dance, 1908-1936*. New York: P. Lang.

Unknown photographer. 1979. *The Company of Toronto Dance Theatre*. Toronto Dance Theatre. [Image] Available at: <https://tdt.org/1978-1987> [Accessed 3 September 2020].

BIBLIOGRAPHY

Art+Technology, 2018. *Louis-Philippe Demers tells human stories with robotics*. [YouTube Video]. 2 November. Available at: https://www.youtube.com/watch?v=ckUsfnv-4oA. [Accessed: 15 July 2022].

Baker, C. and Sicchio, K. 2015. Stitch, bitch, make/perform: Wearables and performance. In *Electronic Visualisation and the Arts*. *(EVA 2015*), London, 7-9 July 2015, pp. 247-251. Available at: https://www.scienceopen.com/hosted-document?doi=10.14236/ewic/eva2015.26 9724631 [Accessed September 25 2023]

Baker, C., Sametinger, F., Ranaivoson, H. and Bryan-Kinns, N. 2019. WEAR Sustain (Wearable Technologists Engage with Artists for Responsible Innovation): Sustainability Strategy Toolkit. In: *Textile Intersections 2019,*12-14 September, Loughborough University. Available at: https://repository.lboro.ac.uk/articles/conference_contribution/WEAR_Sustain_Wearable_technologists_Engage_with_Artists_for_Responsible_innovation_Sustainability_Strategy_Toolkit/9724631 [Accessed September 25 2023]

BBC News, 2020. Facebook, Google and Microsoft “avoiding $3bn in tax in poorer nations”. *BBC,* 26 October. [ONLINE] Available at: https://www.bbc.com/news/business-54691572. [Accessed 3 March 2022].

Birringer, J., Danjoux, M., 2009. Wearable performance. *Digital Creativity* 20 (1-2), pp. 95-113. https://doi.org/10.1080/14626260902868095 [Accessed 21 August 2020].

Braun, V., and Clarke V. 2019. Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health* 11(4), pp. 589-597. https://doi.org/10.1080/2159676X.2019.1628806 [Accessed 22 November 2022].

Chuprina, N.V., Krotova T.F., Pashkevich, K.L., Kara-Vasylieva, T.V. and Kolosnichenko, M.V. 2020. Formation of fashion system in the XX – the beginning of the XXI century. *Fibres and Textiles* 4, pp. 48-57.

Czyzewski, A., 2011. BBC develops 3D technology to enhance sport broadcasts. *The Engineer*, 24 February. [at: https://www.theengineer.co.uk/bbc-develops-3d-technology-to-enhance-sport-broadcasts/. [Accessed 22 January 2022].

D’Amico, L. 2019. A Study of Labanotation and its applications from 20th-century Europe to 21st-century America. In *Proceedings of GREAT Day,* pp. 208, article 12. Available at: https://knightscholar.geneseo.edu/proceedings-of-great-day/vol2018/iss1/12 [Accessed 13 February 2023].

Dawes, R., Chandaria, J., and Thomas, G. 2009. Image-based camera tracking for athletics. *BBC Research White Paper WHP 181*, BBC Research, pp. 1-32.

deLahunta, S., Shaw, N., Forsythe and W., Palazzi, M., 2010. Motion Bank. Available at: http://motionbank.org/en/content/about.html. [Accessed 9 April 2020].

Donnarumma, M. 2024. Works. *Marco Donnarumma*. Available at: https://marcodonnarumma.com/ (Accessed: 17 July 2024).

Carlson, K., Schiphorst, T. and Pasquier, P. 2011. Scuddle: generating movement catalysts for computer-aided choreography. In *Proceedings of the Second International Conference on Computational Creativity,* Mexico City, April 2011, ed. D. Ventura et al. Mexico: Universidad Autónoma Metropolitana, pp. 123-128.

Dörr, E. 2007. *Rudolf Laban: The dancer of the crystal*. Lanham, MD: Scarecrow Press.

Fukushima, R., 2016. Why Labanotation remains. *Loyola Marymount University Dance Department Best Student Papers,* 12*.* Available at: https://digitalcommons.lmu.edu/dance_students/12/ [Accessed 13 February 2023].

Girschig, B. 2019. Living Archive by Wayne McGregor in collaboration with Artist in Residence at Google Arts & Culture Lab. *Experiments with Google.* [Online] Available at: https://experiments.withgoogle.com/living-archive-wayne-mcgregor. [Accessed 13 January 2022].

Gray, J. A. 1988. Dance technology in our lives and work. *Journal of Physical Education, Recreation & Dance*, 59(5), pp. 52-56.

Gray, J. 1989. *Dance technology: current applications and future trends*. Reston, VA: American Alliance for Health, Physical Education, Recreation, and Dance.

Harris, W. 2020. Who invented the computer? *HowStuffWorks*. Available at: https://science.howstuffworks.com/innovation/inventions/who-invented-the-computer.htm#pt2. [Accessed 21 August 2020].

Horosko, M. 2002. *Martha Graham: The evolution of her dance theory and training*. 2nd. edn. Gainsville, FL: University Press of Florida.

Investigatory Powers Act 2016. Available at: https://www.legislation.gov.uk/ukpga/2016/25/contents/enacted. [Accessed 22 January 2022].

The choreography of consent: experiments in dance/law research. Leeds University. Available at: https://essl.leeds.ac.uk/directories0/dir-record/research-projects/1291/the-choreography-of-consent-experiments-in-dance-law-research (Accessed: 30 July 2024).

Johnson-Laird, P. 1993. *Human and machine thinking.* New York: Psychology Press.

Kavalski, E. 2023. Relational theories in international relations. *International Studies* (*Oxford Research Encyclopedias*), 31 January. doi:10.1093/acrefore/9780190846626.013.681.

Larkin, Z. 2022. AI bias - what is it and how to avoid it? *Levity.ai*. Available at: https://levity.ai/blog/ai-bias-how-to-avoid. [Accessed 3 January 2023].

Laricchia, F. 2022. Fitbit Inc. revenue 2010-2021 (Technology & Telecommunications: Consumer Electronics). *Statista.* Available at: https://www.statista.com/statistics/472518/fitbit-revenue/#:~:text=revenue%202010%2D2021,-Published%20by&text=In%202021%2C%20the%20year%2Dend,dollars%20in%20the%20previous%20year. (Accessed: 21 February 2023).

Marchese, K. 2019. The sound shirt lets deaf people feel music on their skin. (Technology). *Designboom*. Available at: https://www.designboom.com/technology/cute-circuit-deaf-people-feel-music-skin-soundshirt-haptic-sensors-10-04-2019/ (Accessed: 03 August 2020).

National Physical Laboratory. 2021. About us: NPL provides the measurement capability that underpins the UK's prosperity and quality of life. *NPL.* Available at: https://www.npl.co.uk/about-us. [Accessed 24 January 2022].

Ochrymovych, A. 2019. An interview with Patricia Beatty and David Earle. [YouTube video]. *Dance Collection Danse*. Available at: <https://www.youtube.com/watch?v=GyirYgj4Fsg> [Accessed 3 September 2020].

Ramani, K., Wilde, D. and Paredes, L. 2020. *Chimera Wearables.* Available at: http://chimerawearables.com/. [Accessed 21 April 2020].

Rogers Rubin, M. and Uri Porat, M. 1977. *The information economy*: *definition and measurement*. Washington, D.C.: U.S. Department of Commerce. Available at: https://files.eric.ed.gov/fulltext/ED142205.pdf (Accessed 21 February 2023).

Saldaña, J. 2013. *The coding manual for qualitative researchers.* 2nd edn. Bodmin: MPG Books Group.

Stewart, G. 2013. Devolution. *Highlike.* Available at: https://highlike.org/text/garry-stewart/ (Accessed: July 19, 2022).

WEAR Sustain. 2021. *WEAR Sustain Knowledge Platform.* Available at: https://wearsustain.eu. [Accessed 21 February 2023].

Whitley, A. 2021. *Alexander Whitley Dance Company: Overflow | Trailer*, *Saffron Hall*. Available at: https://www.youtube.com/watch?v=Jx9F6aPf92Y (Accessed: 12 January 2022).

WOW - World of WearableArt. 2016. *WOW - World of WearableArt.* Available at: https://www.worldofwearableart.com/store/2016-world-of-wearableart-programme/. [Accessed 13 February 2023].

Wu, J. et al. 2019. sEMG signal processing methods: a review*. Journal of Physics: Conference Series,* 1237(3). Available at: https://iopscience.iop.org/article/10.1088/1742-6596/1237/3/032008 [Accessed 25 September 2023].

Zuckerberg, M. 2021. Exhibit A, Meta Platforms Inc., Exhibit 3.1 Facebook, Inc. Amended & Restated Certificate of Incorporation. *US Securities and Exchange Commission*. Available at: https://www.sec.gov/Archives/edgar/data/1326801/000132680121000071/a20211028-exhibit31.htm (Accessed: 3 March 2022).

APPENDICES

Appendix I: Call for Participants

Appendix II: Data Charts

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
130422_improv_response_3_JJB+NGG.MOV.	NGG: In my head you're creating two yous, one dance and one exploration of movement based on those things. Do you see point of initiation versus impetus as different or interchangeable? JJB:They're different but they overlap.	concept of dualism / reversibility?; initating	reflective dualism, deciding where initiation comes from	**the true origins of movement within the body during dance improvisations is deeply individual**	**IMPETUS / ORIGIN**
	JJB: Yes - I feel like any layers change things. More to play with, to tap into the different things. With data, technology, there is extra direction and more boundaries broken.	layering for material development		**being given the choice what impetus to follow produces honest results**	**LAYERS / OPTIONS (OF STIMULUS)**
	NGG: Several revelations for me – fantastic. The idea of almost generating two realms – this is the true reaction to this stimulus, vibrating node, if I was to do x y or z you created a division, an otherness: I understood what you did in the dance world, took that liberty and did that in that whole other world. Fruitful discovery. Helps me to focus- something new, and again talking about anticipation – counting, for example	concept of dualism / reversibility?	looking outside oneself back in for deeper understanding	**externally provided vibrations have the possibility to change dynamic in movement**	**MOVEMENT DYNAMIC**
	NGG: Related to that, yes – The way you describe it - there are two areas, one is a lie or a flourish, not true, unbelievable. Switching roles, Where it was is unconvincing. Where was the buzzer? But I know the buzzer was actually there, raw, natural and honest. JJB:That for me was an important theme, experimenting with phone on my back, the buzzer, and trying to stay true to it rather than adding because what's point of adding if you haven't found the beginning, the source?	concept of dualism / reversibility? Truth in movement; questioning origination (of impetus)	brutal honesty about movement in the body; seeking truth		
	NGG: OK. Any other reflections? JBB: Yes doing the phrase at the end - it's what I know and do but it's interesting setting something when it's come from an improvisation, it's good to know it's come from words not from the vibrating nodes, these improvisations, but when we get together in June with the garments, how are these going to be part of the practice? Will it initiate movement or have we already set the movement - each buzzer tells me what phrase to go into to do and what dynamic - they are two different things but both involve movement	questioning origination; improvisaton / real-live moment	those moments in the studio where indescribable magic occurs		
	NGG: Like two applications integrations, involvement I suppose? JBB: One would be set material almost but based on the algorithm telling me what to do or the other would be a structured improvisation based on where the vibrating nodes happen amongst the body	origin of movement, impetus behind; improvisaton / real-live moment; body points/location			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
130422_improv_response_4_JJB+NGG.MOV.	NGG: Now you have external audio points of impetus reference: how did that feel compared to ones coming from yourself ? JJB: Again like I said it's like adding another layer – it's obviously not all in there at once, a layer taken away - different places I suppose sound taken from phone - the touch one is really interesting even though the technology is working on the left foot you touched me nowhere near there so I moved from the foot whilst feeling where your touch was, giving me like an initiation point – I was still moving but this whole left side of my body was drifting away to the left that's what I felt Touch is good and you get a lot out of touching	in opposition; layering; initation (point); all at once; real-live moment	indescribable moments of magic in live real-time practice, while dancing	**increasing 'layers' (forms of stimulus) can increase a perceived positive experience during dance improvisations`**	**LAYERS / OPTIONS (OF STIMULUS)**
	but it was a little sketchy – ooh, ooh I've got to change, ooh maybe because I didn't know when you were going to change… NGG: Fascinating, an element of surprise then	unexpectedness / surprise	anticipation of something, but then getting omething unexpected	**unexpectedness and anticipation increase honesty in movement**	**SURPRISE / UNEXPECTEDNESS**
	I noticed a sense of urgency or a heightened state, perhaps, when you did that - because instructions were from somewhere else? JJB:Yes, Interesting because not like I'm scared but because it's not coming from myself, I'm doing the task at hand but also I'm like, when's it coming, when's it coming? Anticipation… Yeah	alertness; external instruction; internal instruction	moments of liveness while dancing withing improvisation; where does movement come from - inside,	**having more than one node of vibrating stimulus could present potential for applications of this research**	
	NGG: Going from there to the physical touch point JJB: I suppose because I can see you I don't have to see you before you touch me - I can feel your presence, energy, I already know so I already know it's coming don't know where but didn't know when you were going to change numbers so I'm like oh!– en garde!!	unexpectedness / surprise; external instruction	foraying into new territory of dance improvisation may produce unexpected results		
	NGG: This is the centre back here, this is a fixed point and the rest will be pinned reason I looked at the back and wanted to work with that is because a lot of work at the back because a lot happens at the back specially with contemporary work. The variables in the body are literally endless and I thought this might work.	-			
	JJB: you don't need wires? NGG: No wires attached to you - but if we can figure a place of interest and we can put it there.	body points/location			
	JJB: Just one node? NGG: Interesting point, we'll start with one but we can play with the actual sequence eventually this here in these will .. in these magical iPhones	unexpectedness / surprise			
	NGG: If for example touch this one there's like different ones and these are all pre-programmed by Apple but you can make your own by using this so for example this one created by using this so for example … JJB: Ah nice, then it gives you like the rhythm.	external instruction;			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
130422_improv_response_7_JJB+NGG.MOV	NGG:Now if you could just …if your scapula is basically there, ok before we tried it in this kind of region round here. Now you mentioned in the exercise with the physical touch I think I touched round this kind of area does that feel like it would… JJB: That's a sensitive area … in a good way I would feel the vibrations. A good area.	body points/location; external instruction; initation		**initially expected body point locations to instigate movement were ill-predicted**	**HAPTIC PERCEPTION**
	NGG: Wrist? Outside of wrist? JJB: Yes, you can feel it pretty much anywhere but the best way in my head even before you put it into practice is at the hinging joint is a good place to feel the vibrations coming from - if I felt that there I can push that way which is the opposite or I can go towards and there's more movement whereas if we'd just got it across the back, yes there's movement but it would be a lie for me to go …..it does not do that. It guided it me here, that was the flourish, whereas if I had nodes here I would feel it. I can really feel it- there's a lot going on and it would be the same with the ankle if I felt nodes here it could shift – but joints in general I feel like there's more to play with – as a general understanding it could be here or the other way, front and back.	body points/location; external instruction; initation; in opposition; dualism; truth in movement; external instruction; feeling - physical sensation;	shifting assumptions	**shifting the points of vibration to other body parts, like the extremities, can produce interesting movement results for performer and spectator**	**HONESTY(Y)**
	NGG: Yes, I remember when we had this I talked about ….on zoom we talked about [Martha] Graham's technique – it isn't a factor and makes no difference but this I find interesting it's how I my assumption that things start from the body and …, out from that but that in hindsight also is very much doesn't do that tenet of gravity supposed to start from the body rather interesting	-		**spontaneity as the nexus of movement presents as true movement for the viewer and the viewed**	
	JJB: On the stemum here it would make me dip, If it was here it would make me pull to the side. Could be anywhere really, yes, unless I suppose it's your call whether you go OK with the vibrating nodes - the initial thing is to move away but you could, every time I feel, go towards - but would you feel like that's a conscious decision ? It would have to be ,..? Unless you gave me the explorative freedom to do - oh, pull and push , like play with that, so wherever you would have the vibrating node (s) I could choose to go - repel or be pulled towards.	body points/location; in opposition; external instruction; decision / choice;			
	JJB: Doesn't have to be linear – but as in if we think of it as one of two …In my head if I was to feel something here on my right elbow and i was going away from it, I would do this - it might make me recover but if I was …well that's a lie, All that is a lie. NGG: Why do you say it's a lie, not a flourish? JJB: No, as in with a flourish it's not what this is intended for my body to feel , and recover – I feel it and then I add a flourish which is a very 'dancer' thing to do - but it's not a true feeling that I get from this. Make sense?	truth in movement; in opposition;			
	NGG:It does, is it safe to summarise in a way that you're reacting as a dancer and a non-dancer JJB: Perhaps NGG:Maybe that's too binary ? JJB: Yes…I suppose it's staying true to the task at hand - the feeling at hand - rather than because I'm a dancer and you've brought me in today it's like oh well I have to dance from a feeling and then have to like.. I'm like no, that doesn't make sense from what I felt and if someone did that in front of me I would be like: that's interesting where did you feel the vibration - as a spectator, I'd ask a dancer : where did you feel the vibrations? – In my elbow – I don't see that.	truth in movement; impetus behind; feeling - physical sensation; body point / location; dualism; external instruction			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
130422_interview_10-I_JJB+NGG.m4a	JJB: Point of initiation - for myself, a bone is a point of initiation was my - elbow, the bone at the tip of elbow, but you could say the point of initiation is your heart, a more internal it giving a different understanding of where to shift, but on top of heart is the ribs but it's not from the ribs,but not thinking about my ribs, it's from the heart. More from a deeper understanding of where my body sits. For me it has to be super-direct - if you say move from the hand, which bit of the hand? It can create different pathways, understandings of	internal instruction; initiation; body location /point; feeling - physical sensation		specificity in instruction is key for professional-level contemporary dancers	IMPETUS / ORIGIN
	JJB: Maybe through observation it might look like it's coming from the same body area where it was initiated from but for me if I'm thinking more internally, thinking almost with lift and breath rather than shifting the LH side of my torso over to a side of a space. Thinking of a lift of breath from within to pass through, and go external. Melting into the same understanding but initiated from a different place.	body location / point; initiation; internal instruction; external instruction		variance between what is felt by the performer and how it presents generates positive responses in spectators	TENSION / INTERPLAY
	JJB: Interesting, I have an initiation point for a simple movement like a tendu, but years of work, muscularity makes it easier, now I am more mature with my practice, so things are easier, but the work is always there. NGG:Meaning? JJB: The strength behind what I ask my body to do.	initation; internal instruction		instruction is given and taken individually, framed through common language, but the interpretation is where the interesting stuff happens	SURPRISE / UNEXPECTEDNESS
	JJB: Computers NGG:What do they mean to you? JJB: Future. Now it means socialising - it never used to be but it is going that way now. Progression. NGG:What sort? JJB: A technological understanding of progression	heightened state / alertness		deepening understanding of where movement comes from is required to make sense of adding the variable of artificially generated physical stimulus (vibration)	AGENCY
	NGG:Human gait – G -A -I- T JJB: Almost like auto-pilot?Everyone does it but don't think about it, don't think it's best word but the understanding that no thought, just go …..	unexpectedness / surprise		there is a constant interplay within the artist: what comes intuitively and what is perceived to be good, successful or correct	LAYERS / OPTIONS (OF STIMULUS)

NGG: Is it visual for you first – you mentioned the green letters on the matrix? You had some Colour and movement happening , a digital visual reference? Is it an image that happens first? JJB: Yes, imagery is what I go from	visualisation		**stimulus for movement can come from multiple points and may produce equally varied results in the body**	HONEST(Y)
NGG:Now you've tried the phrase again with a musical score behind it, and you asked me beforehand, do I engage with the music or not - I let you choose, what did you end up doing? JJB: Bit of both. During each individual task, not really listening to the music but phrasing-wise of when to start the next thing - kind of listening to the phrasing and on next phrase going into the next idea.	decision / choice; unexpectedness / surprise; layering; origination (of impetus)			
JJB: Doing same phrase, but music gives a different meaning to where you place your energy: it's another, it's an audible thing – you hear it and you outburst with your movement; it is another layer that you can go on - I have the idea, I have and the sound I can play with that or not, but there's more choice …	external instruction; layering; decision / choice; initiation			
NGG:Fascinating. Some people feel that differentiating here - specifically music rather than sound, can impose a a mood that can produce, maybe too strong, ….it almost forces you to function within the realm it provides. Almost like a liberation from what you say? JBB: You're right, Thinking myself, yes - interesting about musicians, also I do understand that, sometimes I've been in a room so many where we have created the movements to lots of different music then the choreographer specific track and does something different with it… and we're like, that's not what we created..	feeling - physical sensation; decision / choice			
NGG: So with that extra layer, or lens, of point of initiation, was there a big difference between now and this morning when we didn't make that differentiation part of it? JJB: Yes I feel like any layers change things. More to play with, to tap into the different things. Base is data, technology, but there is extra direction and more boundaries broken.	layering; initiation; options;			
JJB: What I enjoyed the most was seeing the development of technology, stillness and inertia - responding to that first , when you initially mentioned the words seeing where we eventually got to – layering of music, you giving me rhythm and tempo or allowing me to have my own space and time …different Waves. trying same idea but thinking about it differently . I think about it like a mind map.	layering; origination (of impetus); choice / decisions; options; dualism; external insstruction			
NGG: Several revelations for me – fantastic. The idea of almost generating two realms – this is the true reaction to this stimulus, vibrating node, if I was to do x y or z you created an division, another you, an otherness: I understood that you said this is what you did in the dance world, took that liberty and did that in that whole other world. For me a Fruitful discovery. Something new. Helps me to focus- something new, and again talking about anticipation – counting, for example,	dualism; unexpectedness / surprise; truth in movement;			
NGG: This idea of unexpectedness or removing anticipation or being in anticipation will be interesting when we add an algorithm change the sequence for us	unexpectedness / surprise			
JJB: Impetus is where something comes from but you don't not have to be (I love how I'm doing the actions to help me) where something starts but doesn't have to start and finish there, just where it starts from.	origination (of impetus); options;			
NGG:Related to that, yes – The way you describe it - there are two areas, one is a lie or a flourish, not true, unbelievable. Switching roles, Where it was is unconvincing. Where was the buzzer? But I know the buzzer was actually there, it was raw, natural and honest. JBB: That for me was an important theme, experimenting with the phone on my back, the buzzer, and trying to stay true to it rather than adding because what's the point of adding if you haven't found the beginning, if not found the source, How can I do the extra?	decision / choice; unexpectedness / surprise; body location / point; truth in movement			
NGG:It's a process of discovery, searching or seeking to find the honest or true source. JJB: Yes, the honesty of the movement – movement exploration	truth in movement			
NGG:OK. Excellent, Any other reflections? JJB: Yes doing the phrase at the end - it's what I know and do but it's interesting setting something when it's come from an improvisation, it's good to know it's come from words not from the vibrating nodes, these improvisations, but when we get together in June with the garments, or whatever, how are these going to be part of the practice? Will it initiate movement or have we already set the movement - each buzzer tells me what phrase to go into and what dynamic - its just a question, because they are two different	improvisation / real-live moment; external instruction; origination (of impetus); descision / choice; in opposition			
NGG:Like two applications, integrations, involvement I suppose? JJB: One would be set material almost but based on the algorithm telling me what to do or the other would be a structured improvisation based on where the vibrating nodes happen amongst the body	external instruction; improvisation / real-live moment; body location / point			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
13.04_reflections_10-R	It was initially a challenge to restrict the urge to direct and choreograph the dancer	hightended state		original assumptions have been challenged: movement does not always originate from the back or deep in the body from a contraction	IMPETUS / ORIGIN
	Working progressively from word association to physicalising the terms seemed to be a nice way of drawing out movement languages, vocabularies… and encouraging them in to phrases Some reactions or responses were unexpected and surprising The point of initiation coming from elsewhere in the body than deep in side of it This developed into a delineation between impetus and point of initialion	unexpectedness / surprise; body location / point; impetus (behind); initiation		the hierarchical dynamic between choreographer and dancer still exists and is difficult to break down, even by reducing direct instructions	
	This revealed the existence of another 'other' functioning within the realm of contemporary dance, to which I then gave the dancer the allowance, permission, license to dance in this realm… the movement seemed to come across more dance-like, more expansive, longer in length, some familiar moves, more performative perhaps	reversibility; dualism; decision / choice; improvisation / real-live moment; external instruction		anticipation / expectation / prediction in movement (even without the technology) creates a movement tension that is positive to watch, likely as it generates more honest results	AGENCY
	I suppose I was consciously trying to extract responses, reactions, movements, physical language from him through means which equalized us, and even perhaps encouraged him to take the lead	options; decision / choice		more layers (forms of stimulus) add to the choreographic experience for the participant, instead of the originally assumed confusion	SURPRISE / UNEXPECTEDNESS
	It was me counting with numbers in different tempos that produced some interesting effects: the anticipation that I would be changing tempo and restarting the count and the unexpectedness of when this happened, meaning it was a true spontaneous reaction/surprise through movement	unexpectedness / surprise; body location / point; impetus (behind); initiation; truth in movement		more than one buzzing node may offer a clear future direction of the research	LAYER / OPTIONS (OF STIMULUS)
	This latter trial is particularly useful as leads to me adding the vibrating motors (buzzers) - as it is a form of physical impetus	impetus (behind); origination (of impetus)		altering pre-defined choreography with physical stimulus sent in unexpected sequences could expand contemporary dance movement languages	TENSION / INTERPLAY
	It was this process of adding layers or 'extra direction' that interestingly the dancer felt gave him more options, more to work with, more to play with…. Something I did not anticipate.	layering; options; unexpectedness / surprise			
	His questions sort of led to crystallizing perhaps at least 2 sections for the end demo: working with the buzzers inspiring pre-set movements/phrases, having different buzzers initiate different parts of the body and the dancers responding on-the-spot in real-time	body location / point; improvisation / real-live moment			
	And this also made me think of perhaps seeing how predefined phrases done without buzzers would then be affected with buzzers sending unexpected sequences of buzzing following the algorithms instruction Maybe this last bit is the crux of the choreographic explorations using physical stimulation?	unexpectedness / surprise; impetus (behind); initiation; reversibility			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATIONS	THEME CONSTRUCTION	THEME DEFINITION
14.04_reflections_10-R	The afternoon sessions when adding the vibrating tech proved fruitful in that they produced reactions and responses in the dancer I didn't expect	unexpectedness / surprise		externally provided vibrations produce unexpected results in dance movement	SURPRISE / UNEXPECTEDNESS
	It was interesting to see the variations of the set phrase when placing the vibrating phone on different parts of the dancer's body, upper left inside lat, lower right side back under the arm just above the natural waist, and then on the abdomen where the dancer said he would normally initiate a contraction	body locations / points; initiation; origination (of impetus)		targeting the general area where a contraction is initiated (in Graham technique) with external vibration was a participant preference, which quasi-aligns with original assumptions	HAPTIC PERCEPTION
	This latter position seemed to be the most interesting and useful to explore how vibration would affect dance choreography	reversibility; origination (of impetus)		the moments of uncertainty when improvising, caused by conflict between impetus sources produced some positive results for the spectator	LAYERS / OPTIONS (OF STIMULUS)
	The reactions/responses of the dancer after the trials with the set phrase were fascinating as it revealed his choice patterning, that he often opted to choose one form of impetus/initiation, i.e. between score, or vibration, or from his own body	decision / choice; options; impetus (behind); initiation; layering; dualism		conversely, when all stimulus points aligned at one precise moment, this produced a parallel enjoyable moment for the spectator	
	In the trial with the score (Harm Hymn) this seemed to produce some moments of uncertainty when he was dancing, as if he wasn't sure what to follow and when… but this also resulted in some beautiful unexpected moments of movement	in opposition; unexpectedness / surprise; decision / choice; improvisation / real-live			
	It was during these repetitions: 1 no music only vibration, 2 then the score he knew (Blues Walk) with vibration, 3 then with a score he didn't know (Four Tet Jalebi) but still vibration, 4 and again another score he didn't know still with vibration (Drw Budr - The Orb) 2 resulted in one key moment where he felt the music stim, the vibrating stim and his own body aligned and her didn't really have to make a choice between the stimulations/impetuses – the lower body was liquid and followed the music, the upper and arms	improvisation / real-live moment; decision / choice; origination (of impetus); initiation; in opposition			
	4 gave some very nice movements throughout and he felt he could allow some slower/draw-out moments even with the vibration happening at staccato	decision / choice; options; in opposition			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_improv_response_11_JJB+EI+NGG_v2	EI: Interesting for me to watch .. when I am choosing to ignore and choosing to go with the flow - really like almost like you were then making me react to you so there was a two point moves?? where I was looking for your impetus, to actually send you a rhythm I need	decision / choice; external instruction; unexpectedness / surprise		choice of instruction to follow offers freedom in physical exploration	AGENCY
	EI: I do think it's because we know each other well having said that but you could set it up with two strangers. But I have the confidence to predict what you'd do, what your style is, maybe. I wonder how much a stranger would just be able… JBB: …to just do and try …	reversibility; internal instruction;	maybe I'm more thinking reflection; self-awareness; embodying empathetically?		

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_written_responses_11-W-JJB_v1	1.Thoughts from [about] the last prototype? Fabric was quite rough on the skin	feeling - physical sensation		the feeling of the physical stimulus on the body is important	HAPTIC PERCEPTION
	3.How does it compare to expectations? The wiring is all exposed at the moment, so I will be super interested to see where this will be hidden on the garment and if it will be uncomfortable or not	options; unexpectedness / surprise			
	5.What does it make you think of? Something from a sci-fi movie	visualisation			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_improv_response_14_EI+NGG_v2	EI: Yeah, like the interplay of like I'm listening but I'm also predicting that you're going to do this.	decision / choice; in opposition; dualism		unexpectedness is related to prediction, and this tension is where AI could effectively be injected	SURPRISE / UNEXPECTEDNESS
	NGG: Did you find yourself trying to buzz because you know the phrase a little bit in terms of like of encourage a flow? JJB: Uh, sometimes. Well as I say, I don't really know the phrase but, like, I kind of knew when.. especially when you do something with the leg, and then point the foot and bring it forward, and then da, and then long…? So you were like d'-da, sshhwwoooooah. It kind of gave you that thing. But most of the time obviously I didn't know the phrase, so I was just kind of playing with…	decision / choice; in opposition		external vibrations can alter movement dynamic, which may be affected by partial knowledge of the existing material	LAYERS / OPTIONS (OF STIMULUS)
	EI: Yeah. What I think is interesting is that my natural movement type is to make everything fluid and quite one level. And actually this is a tool to force me into different dynamic changes … is interesting.	reversibility; internal instruction; external instruction; improvisation / real-live moment; impetus (behind) truth in movement		the wearable technology seems to have the ability to change movement dynamic in the user, and this is a positive user experience	MOVEMENT DYNAMIC
	EI: As just an improv tool specifically, if we could kind of nail the rhythmical sensation of this, it would be a helpful tool. I mean it is that tool now, but that would be another level. NGG: So specific to dynamic? EI: Yeah. Because like this (does one of her moves), if you give me the choice I will always do this fluidly, whereas if I'm being forced (moves more staccato) to break it - yeah - it's a different thing entirely, and it's not a choice I would make naturally.	improvisation / real-live moment; feeling - physical sensation; decision / choice; unexpectedness / surprise			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_improv_response_15_EI+NGG_v2	JJB: So I'd press and you didn't move , and you moved when I let go, and that was interesting… visually when you do that. EI: But to get there I had to wade through the automatic response , the obvious choice.	in opposition; decision / choice; improvisation / real-live moment		conflict in physical response (as in what layer to follow) presents interesting movement language for participants	TENSION / INTERPLAY
	NGG: Get it out of your system almost? EI: Yeah. Then you can… also if the material existed in your body as like second language so you're not thinking about the material, then you can start to think about your choice.	reversibility; decision / choice		affecting existing choreographic material with external stimulus (such as vibration) liberates the body for more choices in movement	AGENCY
	NGG: So do you feel… Is it adding or subtracting choices for you? EI: Definitely adding but it's just about my capability to take the choice. Because it's like there were moments when you were giving me really detailed rhythm, and the music was giving me a completely opposite rhythm. But I was like, ah what comes next in this moment so then I can't have interplay with that rhythm, because I'm hearing the contradictions, and I'm questioning physically what I'm doing. So there's too many options in that moment, almost.	decision / choice; options; in opposition; unexpectedness / surprise; reversibility; options		transferring the agency of choice to the participant causes phsycalised questions, which can produce interesting movement	LAYERS / OPTIONS (OF STIMULUS)

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_improv_response_19_EI +NGG_	JBB: But then it disengaged……Yeah, I suppose it was nice to get different stimulus, then I had the choice of whether to use one kind of kind of layer of stimulus or another or cross them both or completely ignore them – so it was far more options. But once I decided to go with one of them, with the music it's easy, even though I don't know the track, once the 8 count is done I've got the rhythm, so it's very easy to tap into that. Whereas with this, just because it's cutting out a bit I struggle to - apart from what you said about when I saw the initiation I was waiting to start, but then I lost it, like the opposite. It was quite tough.	initiation; decision / choice; layering; options; unexpectedness / surprise;		more stimulus options offer a more positive experience for the participant	LAYERS / OPTIONS (OF STIMULUS)
	NGG: Could you hear the clicking of the button? JJB: No – the music was too loud. Yeah. Actually that had an.. So I couldn't actually respond to that, which is a good thing – so that I am not preempting -because then that would be a lie to the vibration - me just going knowing that she clicked it, rather than me actually responding to the vibration actually responding to the vibration and feeling.	decision / choice; improvisation / real-live moment; truth in movement; unexpectedness / surprise		not hearing the technology in action is preferred while improvising as it elicits truer physical responses	HONEST(Y)
	EI: It's Interesting to be here rather than there..you laughed , as if I was controlling it but I wasn't doing anything – I had stopped pushing quite a bit before that. JJB: No I was laughing because I was waiting for you to click something but you weren't – so I'm like, am I going to wait for the vibration, or am I going to go with the music?	unexpectedness / surprise; in opposition; external instruction		anticipation of the interplay between participants can cause positive or interesting results	

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
170622_interview_19-I_EI+NGG_v2	EI: I think because I felt like I was trying to guess your rhythm then that takes me out of the intention of the movement.	reversibility; external instruction; impetus (behind); origination (of impetus)		participant expressing a positive experience improvising without any technology	HONEST(Y)
	NGG Fantastic. OK – wonderful. And then what about when we got to the physicalised initiation – just to initiate each movement individually? EI: Yes, it's really very enjoyable to do. I can't.. I guess I guess it deepens your connection to the entirety of the movement.	reversibility; impetus (behind); truth in movement;		assumptions not entirely shifted in that the ripple effect can be likened to Graham technique	TENSION / INTERPLAY
	EI: Because often if the movement is coming from somewhere in opposition there's a ricochet from that point through the body rather than it just happening to the external kind of part it that's doing the movement.	in opposition; body locationi / point; internal instruction; heightened state / alertness		direct translation from the stimulus style/feeling to the movement style	MOVEMENT DYNAMIC
	EI: I think it changed the quality, in that because the touch is soft, that naturally sets you into a certain quality, and so I guess that framed the whole word in one particular dynamic, whereas the, like, counting, gave me – there was more dynamic cueing in that, whereas this I would say lulled me into kind of a soft space.	feeling - physical sensation		participants also have preconceptions of what the technology may do within the experiment, within movement	SURPRISE / UNEXPECTEDNESS
	EI: Because I can hear it, but because if you're in the flow it can't interrupt you enough. JJB: Interrupt, yes, exactly, it can't do that.	external instruction; improvisation / real-live moment		pre-existing connection between participants has an effect on the workshop trials	LAYERS / OPTIONS (OF STIMULUS)
	NGG: Can I ask: you said just before because you know Jordan's movement, so did that alter, do you think, the way that you would have interacted with him using this button-y buzzer thing? EI: It would have, more, if it had had the impact I thought it was going to have –	unexpectedness / surprise; in opposition	is this really opposition or perhaps uncertainty? Or a shift in direction simply?	an expectation for a literal translation of the vibration sequences to the receiver, which was then changed	
	EI: So because I know you (Jordan) play with rhythm I was trying to, like, direct your rhythm through this, but it doesn't read, so then the choice is long and short and you're limited to that play, rather than like dah duh duh…	limitation; in opposition; origination (of impetus)		the participant has drawn from previous workshops experience in this research in the decision to claim agency for present decisions; perhaps evidence of potential for longer series of workshops with the same participants	
	EI: Yes, I was expecting to see my rhythm in his body. But then I saw that wasn't – it.. I saw you couldn't read that information because I saw you and you were playing with the end of the sound, end of the sensation, rather.	unexpectedness / surprise; feeling - physical sensation; in opposition			
	NGG: And for you – are you – does it make you only want to move when you get the physical stimulation? JJB: I mean, I was playing in that realm this time. NGG: OK. JJB: If I know I've got the choice to listen, wait, go against, go with, sync it different – well that time I mean I was trying to directly respond to the pattern.	external instruction; in opposition; decision / choice; impetus (behind)			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
17.06_reflections_19-R	The set-up is quite fragile – need to find a more solid way of attaching the motor to the end of the long wires	limitation		a more robust construction of the technology with stronger pulses directly on the body were a participant preference	HAPTIC PERCEPTION
	Important to note that I have allowed the back side of the motor to be in direct contact with the body	feeling - physical sensation; body location / point		passing control to the other participant proved fruitful in that they both felt their movement dynamic changed, and the experience was positive	AGENCY
	Very interesting feedback from both: particularly as they know each other, and their movements styles…. EM knows JJB likes to play with rhythm, so sometimes tried to work with this to help his movements, and other times potentially against it EM said it was a little like a 2-way communication in this way, but maybe because they know each other JJB referred a few times back to Session 1 and his sensation then with working with the vibration when performing the different phrases	in opposition; external instruction; feeling - physical sensation; dualism		short, staccato sequences of buzzing pulses are interesting for the participants to play with	TENSION / INTERPLAY
	This also caused some 'internal conflict' which he felt could be interesting – they both agreed quick staccato buzzes seem to elicit less of a response, over longer ons and offs	in opposition; external instruction; feeling - physical sensation		presenting confusion between machine-made and human-made physical stimulus during improvisation (or performance) may be a future direction of this research	
	Interesting, EM asked what might happen if we repeated the exercise but with the other dancer also providing physical stimulation with their hands/bodies	external instruction; initiation; feeling - physical sensation			

SOURCE (file name)	RAW DATA (1st level CODING in Orange)	CODING (2nd level)	CLARIFICATION	THEME CONSTRUCTION	THEME DEFINITION
080922_demo_extendedsenses_20_JJB+NGG.mp4	Moderator: I've worked in performance interaction but not directly with a dancer before – is there any info you could share with us about relationship you've formulated, particularly with respect to conversations about subjectivity and objectivity? in the fact you are in a research process rather than a directly creative process., there's a whole conversation about that… Could we make that differentiation? NGG: I come from similar training to Jordan but that's not why I selected him. But there is a common language there to be sure to start…it's building on my own knowledge but I was careful to extract myself at least from the first workshop we did - I didn't want to choreograph him or to direct or provide too much instruction. I tried to create an environment in the workshop that was as open as possible, and coming as much from his own lived experience to try and understand how that might affect the ideas I already had.	reversibility; dualism; external instruction; lived experience; options	the moderator appears to be positioning research and artistic practice as opposites, or on a spectrum - herein lies the reversivility (Kozel)	commonality of language from which to build a research relationship in view of advancing the study	AGENCY
	Moderator: What about the control mechanisms that are in place? How can it translate into something that is understood as research? You talk of a degree of improvisation but in terms of feedback and the way you are recording data, how are you managing that? NGG: Remember that this is specifically one practice workshop part of larger system, part of a whole system - this is why I want to do a workshop here, to get responses to that kind of thing, I haven't presented it beyond the realm of my university yet. Obviously there are an awful lot of ethical considerations, practical considerations of documentation, before you begin, all these kinds of things have to be put in place .	external instruction; in opposition; reversibility; communication - system / method;		doubts (perhaps misunderstandings) of approach to research methodology, and practice versus research - why are they to be opposites?	HAPTIC PERCEPTION
	Katy: Hi, thanks Nigel and Jordan, it's just a question about the wearable tech - I come from a dance background and am researching dance and wearable tech for my Phd .I'm interested about the tactile stimulus - are they on a loop, is it patterns of vibration? What's happening underneath? NGG: The algorithm I co-created with a statistician is built from my own motion captured movement so it is for me processed by that rhythm through an algorithm translated through this participant loop so in that respect I'm interested in the unexpectedness: he doesn't know what to expect and I don't know what instructions will spit out, so it's the integration of something that is in theory intangible to something that is very tangible in this way.	external instruction feeling - physical sensation; improvisation / real-live moment; communication - system / method; unexpectedness / surprise		inquiries into the stimulus types and delivery methods via the wearable technology, and what effects that can have on another body during dance improvisations	
	Questioner 2: Hello, my question is that when I was a participant, I felt my experience was pretty much a question about control, it felt very like being a puppet; you talk about it as influencing the dancing, from this perspective of control, because it's very hierarchical, at this point at least, are you thinking maybe of some feedback process? Not sure how to .. NGG: We talked a lot about Jordan making decisions about what he's going to actually follow which is why we added layers and removed them - does he listen to the score , is it the space, internal feeling …vibrations, does he ignore this or that. A beautiful thing to emerge for me is the sense of confusion - too strong, - uncertainty - something would happen physically that's really interesting, that's quite valuable	external instruction; origination (of impetus); communication - system / method; decision / choice; layering; internal instruction; unexpecteness / surprise; reversibility; in opposition		including other participants on the sending end of the system may have benefits, and could reduce bias in the workshops process	
	Questioner 3: Thanks for the presentation and the practice. I'm interested in how you navigated the choices of the placement of the physical nature of the thing NGG: During the first workshop process some of the feedback from participants was about – what if we put it on wrist? - those kind of things. So I changed the wearable design to allow for that – to reflect that idea we tried it in one place and moved it around. The harness thing is going on at the moment - the next stage is a suit that goes on top so the wiring is not a hazard, so perhaps two dancers can interact with each other in a much safer manner So, initially I thought it would be something that's in the dancer's back, as that's where I came from but it moved to everywhere else after feedback from participants	body location / points; unexpectedness / surprise; dualism; communicaiton - system / method;		responding about the shift in assumptions in relation to where dance movement originates in the body for each individual, leading to a design adaptation	

Appendix III: Session 1 Workshop Design – Chart

Royal College of Art
Workshop / Rehearsal / Demonstration
Studio Wayne McGregor, Here East - Stratford

RCAPGR 2021/22 Teaching Dates: 13 Sept - 17 Dec; 10 Jan - 1 Apr; 25 Apr - 9 Sept
UCAPG Teaching Dates: 27 Sept - 28 Jan; 31 Jan - 3 Jun; 6 Jun - 23 Sept (TBC w/ Camille)

Scheduling	Potentially between 21 Feb - 3 March 2022		Prototype Design Development Stage	Possibly (ideally) last week of March 2022, or first week of May (additional weekend 2 days if needed)				
Resources	Nigel, Dancer 1, Dancer 2, Videographer (full day)	Nigel, Dancer 1, Dancer 2, Videographer	Nigel, Technicians	Nigel, Dancer 1, Dancer 2, Videographer (1/2 day)	Nigel, Dancer 1, Dancer 2, Flora, Camille	Nigel, Dancer 1, Dancer 2, Videographer (1/2 day), Tech Support, Audience	Nigel, Dancer 1, Dancer 2, Videographer (1/2 day), Tech Support, Audience	Nigel, Dancer 1, Dancer 2, Videographer (1/2 day), Tech Support, Audience

	Time	Day	1	2	approx. 1 month?	3	4	5	6 (Sat?)	(~7)(Sun?)
MORNING	10:00 - 11:15		Hello, introductions, project presentation, consent forms	Warm-up		Hello, welcome back, warm-up	Warm-up	Warm-up		
	11:15 - 11:30		BREAK	BREAK		BREAK	BREAK	BREAK		
	11:30 - 13:00		Dancer 1: 45 minute interview; Dancer 2: 45 minute interview	Composition through improvisation session 1		Test session - 2nd round prototypes	Composition through improvisation session 5	Rehearsal		
	13:00 - 14:00		LUNCH	LUNCH	*Q: add in algorithm?*	LUNCH	LUNCH	LUNCH	warm-up	warm-up
AFTERNOON	14:00 - 15:30		Test session - 1st round prototypes: dancer 1 solo; dancer 2 solo	Composition through improvisation session 2		Composition through improvisation session 3	Composition through improvisation session 6	Rehearsal	Rehearsal	Rehearsal
	15:30 - 15:45		BREAK	BREAK		BREAK	BREAK			DEMO?
	15:45 - 17/18:00		Test session - 2 dancers together	Dancer interviews & wrap-up		Composition through improvisation session 4	Open discussion, preparation for demo	DEMO?	DEMO?	

Revised Workshop Plan

DAY 1
9.45 arrival
10:00 - 13:00 morning session
Set-up: camera, equipment, prototype (perhaps on separate table?)
10:00 - 10:15 - Introduction
Keep project details and explanations minimal in view of not over-influencing the participant to begin with - explain some basic ground guidelines:

- explain am recording some parts via sound, some via video, some via photography
- Supervisors to attend in the afternoon, so would like to have something to show them, but this can remain undefined for now
- Videographer joining us 2nd day
- Process of exploration, research, investigation
- Reveal as we progress
- Nothing is wrong
- Initial reactions

10:15 - 10:45 Point of Initiation - where movements come from

- preconceptions/brainstorming: technology, data collection, human gait, automation, complex movement, simple movement, impetus, inertia, movement ends, connectedness, reaction, stimulus, response
- Then move into:
- Point of initiation more generally through to individually, collectively
- Where else could they come from? Is it always one specific point?
- How does sound/music play into this?
- What if it is someone else providing that inspiration / instigation?
- What if it doesn't come from where you want it to?

10:45 - 11:00 Prototype

- initial thoughts?
- Fittings
- Explanation of how technology may be involved
- Adjust for comfort, logical placements
- Show options of t-shirts with Velcro as variations
- Photograph everything with notes for subsequent prototype building

11:00 - 13:00 Phrases & Variations
Through improvisation - from points of initiation

- solo improv using internal, self-identified points of initiation
- Using vocal / sound cues for point of initiation - improv
- Using touch at one point for initiation - improv
- Using proto own participant without tech
- Using proto on body with phone vibration for inspiration
- Play-back to gel into a phrase or phrases
- Capture each phrase, with view to showing supervisors / after lunch

13:00 - 14:00 Lunch
14:00 - 14:30
Revise/review/revisit phrases to gel more / solidify
14:30 - 14:45
Supervisor introductions
14:45 - 15:30 Demonstration 1

- outline session plan for supervisors & participant
- Central guidance sought from supervisors: adaptation of choreography towards an output to research in an academic context
- Request supervisors to observe, make notes/comments, keep them for after we have gone through the material
- They will be able to look at the kit / gear / proto separately in detail afterwards
- Demonstrate the phrases we have created in sequential order with brief introductions
- Work to develop them with my input/shaping for a new variation / version of each
- If time, show 1 or 2 with participant version only / then with my version

15:30 - 16:30 Discussion / supervision meeting

- invite commentary / questions from supervisors: for me, for participant, for both
- Outline process we went through to this point, what the plan is for tomorrow, plan for Session 2, what to be done with the material/data
- Suggestion on data analysis methods to use?
- Feedback/input/advice for tomorrow, following session?

16:30 - 18:00 Processing & Interview
Supervisors welcome to stay and observe

- Process their feedback and figure out what might need to be implemented for tomorrow
- 1-1 semi-structured interview with participant (maybe in separate meeting room?)
- Explain tomorrow's aim is to build a set of phrases through a similar process but perhaps more developed
- Capture with video and photography

DAY 2 - 14 April

09:45 - 10:00 Studio arrival & introductions to videographer

10:00 - 10:30 Video/photo set up & day preparation
10:00 - 10:30 Set-up open discussion with participant, to be filmed; give day outline

10:30 - 11:00: Reflections on previous day

- how did it go for the participant?
- What was the experience like?

11:00 - 11:30: Revisit phrases to recall them, filmed
11:30 - 12:30: Creation/development of phrase with participant solo, internal initiation - repeat to film as needed
12:30 - 13:30: Creation/development of phrase with phrase with external initiation (sound, verbal/voice, music, touch) - repeat to film as needed

13:30 - 14:30: Lunch

14:30 - 16:30: Prototyping - technological choreography - video coverage

- Involvement (for videographer)
- Explain to camera how the tech can mimic intended artificial point of initiation
- Creation of phrase using different proto versions (no tech): straps, t-shirt, long-sleeve (?)
- Film participant putting proto on, adjusting, getting it working with the tech
- Experimentation of natural, flowing improvisation initiated by vibrating buzzers in different places
- Develop this into a more cohesive phrase collection of movements?

16:30 - 17:15 Interview

- Semi-structured interview, filmed, using question guide
- Meeting room?

17:15 - 18:00

- wrap-up, any missed shots, questions
- Plan for Session 2
- Thank you

<u>170622</u>

<u>SESSION 2 - SWM Studio 2 - 1 day - 2 dancers</u>

Proto garments now complete, with mounts for electronic wearable remote buzzer system
Attached snaps to mount so the 1 set can be removable
Assembled with soldering to long wires and worked when at home
Works from button on base, which can now be plugged into the wall or laptop port for power
Does not need wifi for 2 ESP32s to communicate - they have been programmed to ‘speak’ to one another via Bluetooth, and for the dancer-mounted apparatus to cause the motor to vibrate

MORNING

Asked Jordan to refresh Phrase A and sent him iPad video of him doing this phrases without any other score/stimulation

Point of Initiation - where do movements come from?
More generally through to individually, collectively
Where else could they come from? Is it always one specific point?
How does sound/music play into this?
What if it is someone else providing that inspiration / instigation?

EM - verbalizing, physicalizing words (similar process but w/ new words); then get responses from 6 existing words (?)
Look at similar material building process with Eileih:

- apparatus | articulated | sequential | bionic | harmonious | contraption | response | concept | whole | opposition | blatant
- word association: 6 words selected, then broken into 2 groups
- Build from these 6 to form Phrase C

JJB - written responses

Show him proto - instead of verbalizing, have him write down his responses

- Thoughts from the last proto (give him 1st proto)
- How has it developed?
- How does it compare to expectations?
- What's different?
- What does it make you think of? What's isn't there?

Come back - JJB show Phrase A
EB show her phrase C

Use same techniques to alter these 2 phrases: voice counting, voice / tempo, score(s)

CONTACT: advantage of having 2 dancers in the space…
How can each phrase section be affected by the other's touch?

Consider meshing them together with contact improv to form Phrase D? - save for the afternoon

PULSE Blues Walk - teach EB this phrase while refreshing JJB - save for the afternoon

FITTINGS - so I can make adjustments over lunch - thread the wired through safety pins on wide elastic so they're movable/adjustable when the dancer is moving
Try and find a set up that works for both bodies

LUNCH

AFTERNOON

Try garments on with different placements of vibrating motor
Get both garments on, but 1 with electronics
If iPad can serve as power source for base, then have 1 dancers press the button to stimulate the other while they're in the space moving - otherwise seated

Look at Phrase A and C with the vibrating stimulus - me pressing button, or other dancer (both if time)

Look at Pulse with 1 dancer having vibrating stimulation, and the other not, but both performing the same phrase

REFLECTIONS

Verbalized and recorded
Thoughts of the different forms of stimulation, impetus, artificial, buzzing, voice, etc
The working and development process

PLANNING FOR SESSION 3 + DEMO

CLOSE

Appendix IV: Messenger Chat - Leah Gerber Davis

This is the transcript of a Facebook Messenger chat I had with Leah Gerber Davis on 13 April 2019. I have redacted extraneous parts of the text to focus on the key themes, which I refer to in the Preface and in Chapter 5.

Algorithm for Draping: Background

A sample of data export would be most useful
Nigel
OK
Leah
And then to get an idea of what you'd want to do with it
I know I have to think differently
Generally I have groups that I want to compare specific parameters
Nigel
i think I'm hoping the data will be something we can feed into the algorithm so it spits out similar forms of data that can be 'translated' by the wearables and their vibrating elements
Leah
You may not have a 'question' like is A different from B among these parameters
Nigel
good point
but i remember when we worked on the first algorithm
you asked me series of questions
to determine parameters
Leah
Yes. […]
Nigel
and that creative process is what we used collaboratively to come up with how you'd build the algorithm
[…]
you asked things like: do you want simple or complex polygons?
how many sides do you want; between what and what
do you want to restrict angles?
if so between what and what
[…]
Leah
Yes.
Nigel
we were working with shapes and polygons for me to design a garment with
Leah
Yes, like here's a pile of octogons. Make a garment
Nigel

we also determined that the same process could be applied to movement.... corners of the room have number, angles in the body, the coordinates of the joints in space
yes
exactly
we worked with fewer shapes

Leah

I'm picturing instructions like 'Dance making only right turns and you can't use your left elbow'
[…]

Nigel

but the amazing part was that after we created the parameters I wanted to be 'forced' to design with that was produced - that it was an unexpected result to work with
yes you are not far off
[…]

Role of Data and Ethical Considerations

Nigel

[…]
the first relates to the role of data in my work and with this project

Leah

The same thing gets asked of doctors. They might find something cool and someone always asks 'how is this clinically relevant? Should I change my practice and how?'

Nigel

yes very good questions

Nigel

for me I think the role of data is because I think the concept of robotics, AI, machine learning, data sets being recorded by giants (Facebook!! websites, government, etc.) needs to be interrogated more thoroughly than it has been... we need to catch up the ethics of the value of data and why it is so valuable

Nigel

essentially my theory is that there are elements of humanity of creation, of emotion and 'live' experience that can not be replaced by robots
or AI or any other form of non-human essence
so.... although I would be creating data sets with MoCap (or other means) I am very cognizant that there is the potential to 'steal' or own this data
watch this when you have 3 mins: https://www.youtube.com/watch?v=qshkvUOc35A

"Living Archive: A tool for choreography powered by AI
Introducing an experiment with multi-award-winning choreographer Wayne McGregor and Google Arts & Culture Lab: Living Archive - a tool for choreography power..."

Leah

So are you trying to show how the data could be used badly?

Nigel

so I am employing data in my work to show that there are significant parts of humanity, and - most crucially - human creativity - that cannot be replaced by some form of robot.... you can USE robotics, AI, machine learning, coding, etc. as part of your creative process but they are PART of it, they cannot REPLACE

Leah

Ok

Nigel

good point.... maybe showing how it is already used badly would be a good case study to include
there are so many examples

Leah

My job is always to turn the idea into a testable/feasible experiment

Nigel

yes
so maybe you're right.... show how it is a disaster

which is why I am challenging it
which is why many people are in different ways
we have to

Leah

But you showing you can't do it well doesn't show it's not possible

Nigel

precisely
which is why it is a case study to approach a larger point

Leah

A different robot or AI process might be able to do something well that we can't do

Nigel

I don't think I will be able to disprove thousands of people's research in that robots canNOT take us over.... within the scope of this PhD
and yes you're probably right
we don't know how far they can go - robots I mean
but we need to look at the 'why'
why are they trying to?
why do people want them to?
[…] I want to show the role of data in the journey of my exploration
[…]
but art / design research enables and raises questions in ways and with strength that other methods […] cannot

Leah

Is there a way to quantify or qualify what pieces robots can't do well

Nigel

because there is humanity and emotion involved
[…] that would likely be a post-doc`
[…]

Leah

Is it transitions or fluidity?

Nigel

experimental psychology and neurology are shedding some light on that area

Leah

Or just emotion
[…]
A cartoon animal can make you sad

Nigel

emotion is something no scientist has ever been able to understand or map or document properly
i think there is a reason for that

Sequences of Morse Code

for example: say we are able to create an algorithm that is able to process the movement sequence I have come up with.... translate it into a sort of Morse code where the wearables that contain vibrating devices can then buzz away as sequences of stimulus.... and these wearables are worn by very well trained dancer....
[…]
that single, one dancer will respond to the exact same sequence of buzzes differently every single time even if I gave the instruction to do the EXACT same movement

Leah

And a different dancer completely differently

Nigel

or just let them respond as they liked
yes exactly
and someone experiencing this process unfold in front of their eyes will feel differently every time

Leah

Is that the same with choreography?

Nigel

an audience
a viewer
[…]
YES!

Leah

Not exact
Has a personal touch?
Same with written music

Nigel

but what happens what you approach 'choreography' using MoCap + algorithm + buzzing sequences + wearble + dancer
'personal' I'd say is an understatement
even if we reduce the number of variables to a minimum
so 1 dance sequence, 1 algorithm that doesn't change, 1 buzzing sequence it creates, 1 wearable, 1 location on the body, no instruction and 1 same dancer

Communication System

Leah

Would be interesting to look at multiple dancers with multiple repeats

Nigel

it will always be different

Leah

And see if when you cluster you can pick out the 'person'

Nigel

NOW you are seeing where I am coming from

Leah

Or 10 dancers get 5 sets of instructions each

Nigel

yes hence why I am starting with myself and then one other dancer and then multiple

Leah

Can you cluster by dancer or set of instructions
If you put the data together

Nigel

the 'instructions' as you call them are coming from the algorithm

Leah

Yes.

Nigel

which is from us
and the data going 'into' it is from me
it is a system... of communication, of choreography

Leah

So if you and I get the 5 different sets of instructions could we determine which results are you?
And which results are instruction 1?

Nigel

hmmmmm very good point
I hadn't thought of it that way

Leah

Thinking cluster analysis

Nigel

I think we would have to build and test the system first... and then start changing the 'input'
is that what you mean?
but hidden so we don't know if it is me or someone else

Leah

You have input 1 and say have 10 dancers do it

Nigel

yes

Leah

Then another input and the same 10 dancers do it
Nigel
that order is what I was originally thinking
[…]

Labanotation for Datafication

Leah
Depends on what data is collected
I have no idea what sort of data you'll Have
Nigel
well that is why I was looking at MoCap
or Labanotation
Leah
Could also do so many things in the future like here is instruction 1 and make it sad
Nigel
or simple things like corner numbers of the room, coordinates of the dancer in space in 2D and 3D
Leah
Or happy
See what changes
[…]
Leah
You can credit your statistician as the biggest pain in your ass
Asking you the same question over and over
Nigel
[…] that is exactly what is helping me though!
[…]
Leah
Ok. So why are we using an algorithm to inform the dancers versus a random Sequence?
Nigel
the choreographic notes could say 'grand battement a la seconde to the right on count 3-and with arms in 5th' for example
but how that actually happens in real time is like night and day depending on so many factors
i think I want to use one given algorithm that we co-create like another level of creativity in the process
like having a dance master stage my movement on some else without me there
but with less restrictions
maybe the variances and nuances the algorithm creates end up producing a nicer piece of work
a better more pleasing dance phrase
and 'better' is in the eye of the beholder / the audience, in this case
Leah
I see. Maybe see what parameters produce a more Pleasing outcome?
Nigel
perhaps... but it depends on who is 'judging' the outcome.... maybe here it would likely be me as the researcher
Leah
That could be dancer specific. Dancer A could make anything nice and Dancer B always awful
You could have a score sheet like figure skating
Nigel
well this is where Labanotation could come in
it is like the score of movement
[…]
but yes

Aims With Data

Leah
[…] What do you want to say with the data
Just having data means nothing

If we don’t do something with it

Nigel

that it is a useful tool that will generate new ways of creating movement; that it can be a catalyst in the choreographic and indeed creative process; that the fact it is recorded binary data allows for clearer dissemination of […]
results
that data capture and process through coding or algorithmic means can advance movemental creation processes in new ways; but that it will not replace existing methods; a symbiotic approach is new way forward for movement creation that wasn't previously possible

[…]

Leah

How will your work show this

[…]

Nigel

but those are clear aims
[…]
that is where the choreographic process exploration and demonstration comes
in
so we have to build an algorithm than can process data sets generated from coding my own movement...
and then I have to show how that step is part of a process that doesn't yet exist
and that this system is in itself - including the original algorithm - a new way of creating movement
and recoring it
recording
and demonstrating that process will be my viva!
[…]

Appendix V: Research Ethics

Ethics Application – 29 July 2018

Royal College of Art
RESEARCH & INNOVATION

Stage 1 Research Ethics Application Form (Staff & Research Students)

Section 1: Details of the Researcher and their Research

Applicants carrying out research with children or vulnerable adults may also need to carry out a recognised Safeguarding course and submit the pass certificate with their ethics application. Please refer to the RCA Ethics Policy for guidance or contact your Supervisor or ethics@rca.ac.uk.

Researcher Details

First Name	**Nigel**
Surname	**(Guérin-)Garnett**
School	**Design**
College email address	**nigel.garnett@network.rca.ac.uk**
Name of Partner Institution(s) (if applicable)	**n/a**
Are you: (please select)	• Research (MPhil/PhD) Student

STUDENTS

Student Number	222001
PGR – Primary Supervisor	Flora Mc Lean

Research Details

Title of your research project	Material Interfaces : Algorithms to Movement
Name and institutional affiliation of any research collaborators	
Date of application	29.07.18
Brief Project Summary (up to 700 words) NOTES: Please summarise your research; try to avoid jargon and acronyms that a non-specialist reader might not understand. Please use the following headings: *Methodology* *Theoretical approaches* *Research questions* *Details of participant population (recruitment, inclusion and exclusion criteria)*	Methodology Interviews and discourse are an important methodology amongst the mixed approaches I am employing in my research. Many are on-going discussions with academics and professionals in fields related to my lines of inquiry. Subject areas of note include soft robotics with the Robotics Academic Lead, Dr. Sina Sareh; smart textiles researcher and tutor, Dr. Sara Robertson; artist and cross-modal researcher Dr. Tereza Stehlikova; and head of the School of Design Research, Dr. Ashley Hall. I have also arranged for a September interview with Ruairi Glynn at The Bartlett School of Architecture based around his expertise in interactive architecture and design for performance. Other links formed outside the Royal College of Art are with Dr. Becky Stewart at the materials science department in Queen Mary University of London through Dr. Robertson, as she is interested in the relationship between electronics and performance. I also have been in discussions with Leah Gerber Davis who is a biostatistician based at Duke

1

University Hospital. These in-depth conversations are continual as I am collaborating with her to create the algorithms I hope will elicit movement.

Presentations of my research to MA students, lab technicians and fellow postgraduate researchers is another methodology I have been using. It has offered different perspectives on my research as it progresses. I have posed questions to generate group discussion and they have each challenged areas of my research, which has furthered my thinking and highlighted areas that need defining or improving. I also used a written questionnaire with a focus group of design professionals while presenting my research followed by the collating the results.

Material trials and explorations have also constituted a considerable portion of my methodology. Working mainly with different kinds of leather, strapping, elastic and foam I have been making several artefacts in which I intend to embed various kinds of stimuli. These wearables are intended to create an 'artificial' point of initiation for the dancer who wears them. I have also experimented with muscle wire but have deemed that other techniques are more effective. I am looking at soft robotics, electrical stimulation, changes in temperature, smart textiles, arduinos, intertia measuring units (IMU's) and other sensors as various kinds of material interfaces to stimulate the wearer. These wearables are intended to transform impulses determined by the algorithms I build with the statistician into tangible stimuli for the dancers.

Once some wearables are fit for use I can use further qualitative data collection methodologies. The process would begin with myself as the participant followed by adding in professional dancers as participants. Most formalised dance training teaches that all movement must originate from somewhere in the body. Although a dancer is never truly static this is the moment when inertia occurs. It is often imperceptible to anyone but the dancer themselves. But in each case this is the instant that is of interest.

I would use a control versus variable approach. For example, a *tendu* (literally translated to 'stretched', where the foot is extended from the centre passing from flat to point where only the toes are touching the floor) is a staple movement learned in most codified dance techniques; it is also heavily documented, particularly by institutions like the Royal Academy of Dance. I would individually ask the participants to execute the control movement (*tendu*) as they would normally and describe where that movement comes from in their own bodies. We can then add variables. For instance, change the instruction for initiation to be from elsewhere in the body for the same movement. The wearable pieces I am making would be yet a further variable as they would imitate the points of initiation for the dancer instead of them being self-initiated.

Using the same control versus variable approach I would then explore more complex movement within modern and contemporary styles. (Martha) Graham technique movement comes from a contraction deep inside the body and it takes years to 'find your contraction' as it is individual and internal; a teacher cannot manipulate a dancer's body to achieve his/her own contraction. Building articulated/flexible wearables for the back, torso and pelvis would allow a richer movement language to be investigated.

Every stage would be recorded using surveys, questionnaires, video and sound. This would allow for closer analysis due to the difficulty in simultaneously being involved in the process itself.

<u>Theoretical Approaches</u>

Recipes tell you how to accomplish a task by performing a number of steps. Similarly, an algorithm is a sequence of instructions or sets of rules that, when followed, execute a task.

In my previous work I also collaborated with the same

biostatistician, Mrs. Gerber Davis, to build an algorithm that could produce polygons. I determined parameters that could be used in building the shape-producing recipe. Things like the numbers of sides, length of sides, complex or simple polygons and degrees between the arms were all sets of rules that enabled us to input data into the algorithm so it could spit out new data. I used the new shapes that were created to design a garment. The same process was approached for dance choreography but although data like the corners of the room and joints in the body were viable options the study was insufficiently robust at the time. Reflecting back on the creative process it has now become apparent that it was a system I was trying to create, not a completed piece. It is therefore the defining, codifying, exploring and documenting of that system which will likely make up the bulk of my current research project.

Within the field of biomechatronics Professor Hugh Herr has designed devices to enable the disabled to walk again with a previously unachievable normalised gait. Instead of creating an AI program that mimics human motor skills his lab at MIT is tapping into the nervous system to use the brain's synaptic communication system. Where Herr's area focusses predominantly on pedestrian and sports movement my study investigates the kinesiology of non-pedestrian, extreme movement through similar but non-intrusive means. This practice-based research explores the interface between wearable accessories embedded with sources of stimulation and dancers' artistic expression.

Research Questions

How can the kinesiology of material interfaces develop a new choreographic system?

What happens when existing, codified dance movement is artificially initiated by a wearable device from different points on the body? What movement languages will this create?

Keywords: kinesiology | systems | wearables | dance choreography | body | initiation

Details of Participant Population

They will be recruited through my existing links in the London dance field and through legitimate, online industry sites that post jobs and auditions. I have also composed a list of the major dance programs that offer a minimum of a BA (Hons) degree in dance performance that I can approach for their recent graduates, alumni or particularly strong 3rd years.

I intend on using professional dancers to see how they respond to the material interfaces I create. They must all be above 18 years of age and ideally of professional standing. There will be no exclusion based on gender, ethnicity, beliefs, sexual orientation. They will be selected based on their technical ability, artistic expression, maturity, ability to articulate their experiences and general interest in this project. All participants will be voluntarily consenting to take part in the project and the research will be done overtly.

Please explain the potential value of your research to society and/or the economy and its potential to improve knowledge and understanding.

This research could sit in three arenas that may offer new knowledge:

1. Well-being: new postural, mobility and kinesthetic understanding and benefits. Aside from walking, sequential movement in biomechatronics has not yet been achieved.
2. Product: material and technical investigation in the development of a successful wearable device. Seamless movement in robots has not yet been achieved.

	3. Creative: the inspiration for dance to explore new movement using wearable technology. Developing a new choreographic system. Within the scope of this PhD my focus currently lies within the third, but with a view of subsequently approaching the other two.
Is your research secondary or desk based research **only**? (see Ethics Policy section 8.7 for definition) If yes, you do not need to complete the checklist in Section 2. You do, however, need to be certain that all components of your research will fall under this category.	No

Section 2: Research Ethics Checklist
(Refer to Section 3 for an explanation of the colour coding.)

You must provide a response to ALL questions. Please refer to the RCA Ethics Policy for guidance or contact your Supervisor or ethics@ethics.ac.uk.

	Will your research (delete as appropriate):			
1	Involve human participants?		YES	
2	Create a risk that individuals and/or organisations could be identified in the outputs?			NO
3	Involve participants whose responses could be influenced by your relationship with them or by any perceived, or real, conflicts of interest?			NO
4	Involve the co-operation of a 'gatekeeper' or institution to gain access to participants?		YES	
5	Offer financial or other forms of incentives to participants?		YES	
6	Involve the possibility that any incidental health issues relating to participants be identified?			NO
7	Involve the discussion of topics that participants may find distressing?			NO
8	Take place outside of the UK?		YES	
9	Cause a negative impact on the environment (over and above that of normal daily activity)?			NO
10	Involve gathering or preparing non-living biological samples *not held already* in a university, museum or other collection?			NO
11	Collect, use or store any human tissue or DNA (including but not limited to, serum, plasma, organs, saliva, urine, hairs and nails)?[1]			NO
12	Involve medical research with humans, including clinical trials or medical devices?			NO
13	Involve the administration of drugs, placebos or other substances (e.g. food, vitamins) to humans?			NO
14	Cause (or have the potential to cause) pain, physical or psychological harm or negative consequences to humans?			NO
15	Involve the collection of data without the consent of participants, or any form of deception?			NO
16	Involve interventions with people aged 16 years of age and under?			NO
17	Relate to military sites, personnel, equipment, or the defence industry?			NO
18	Risk damage/disturbance to culturally, spiritually or historically significant artefacts/places, or human remains?			NO
19	Contain research methodologies for which you, or members of your team, require training to carry out?			NO
20	Involve access to, or use (including internet use) of, material covered by the Counter Terrorism and Security Act (2015), or the Terrorism Act (2006), or which could be classified as security sensitive?[2]			NO

[1] For any research involving human material you must contact the RKE Office (ethics@rca.ac.uk) for further guidance on how to proceed.

[2] The Counter Terrorism and Security Act (2015) and Terrorism Act (2006) outlaws web posting of material that encourages or endorses terrorist acts, even terrorist acts that have occurred in the past. Sections of the Terrorism Act also create a risk of prosecution for those who transmit material of this nature, including transmitting the material electronically. The storage of such material on a computer can, if discovered, prompt a police investigation. Visits to websites related to terrorism and the downloading of material issued by terrorist groups (even from open-access sites) may be subject to monitoring by the police. Storage of this material for research purposes may also be subject to monitoring by the police. Therefore, research relating to terrorism, or any other research that could be classified as security-sensitive (for example, Ministry of Defence-commissioned work on military equipment, IT encryption design for public bodies or businesses) needs special treatment. If you have any doubts about whether your research could be classified as security-sensitive, please speak to your supervisor and/or the RKE Office (ethics@rca.ac.uk).

21	Involve you or participants in a) activities which may be illegal and/or b) the observation, handling or storage (including export) of information or material which may be regarded as illegal?			NO
22	Require ethical approval from any recognised external agencies? e.g. NHS, Social Care, Ministry of Justice, Ministry of Defence. Please refer to the Question Specific Advice for the Stage 1 Research Ethics Application Form and Code of Practice for Applying for Ethical Approval for further information.			NO
23	Involve individuals aged 16 years of age and over who lack 'capacity to consent' and therefore fall under the Mental Capacity Act (2005)?			NO
24	Pose any ethical issue not covered elsewhere in this checklist (excluding issues relating to animals and significant habitats which are dealt with in a separate form)?			NO

Please note that the Research Ethics Committee will refer to the Dean's Group any application where, in the view of the Chair, the proposed research poses a risk of a legal or security related nature to the RCA. The Chair will seek guidance from the Dean's Group before the Research Ethics Committee decides if the proposed research can be granted ethical approval and/or the nature of any special arrangements which need to be put in place.

Section 3: Approval Process

All student applications must be sent to your Supervisor for checking.
Your Supervisor must then forward the application to the appropriate REC (as appropriate)

REC = Research Ethics Committee

NO answered to all questions
Risk category Green

Tier 1 Complete Section 5 of this form and then send it to ethics@rca.ac.uk
You do not require ethical approval from a committee.
You can start your research immediately.

YES to any of Questions 1-10 and/or 24 but NO to all other questions
Risk category Yellow

Tier 2 Complete Section 4 and 5 of this form, the Participant Information Sheet (PIS) and Participant Consent Form (PCF), and send to ethics@rca.ac.uk for Consideration at the next REC. You may be required to provide further documents.
You need to wait for ethical approval before you start your research.

YES to any of Questions 11-21
Risk Category Red

Tier 3 Complete Section 5 of this form and complete the Stage 2 Approval form. Submit both, and any other documents required, to ethics@rca.ac.uk for consideration at the next REC.
If you answered YES to Question 20 you must also complete and submit for consideration by the committee the Stage 3 Approval form.
You need to wait for ethical approval before you start your research.

YES to either or both of Questions 22-23
Risk Category Purple

You need external approval(s) which, if granted, may be regarded as equivalent to approval from the RCA Ethics Committee.

Refer to the RCA Research Ethics Policy for further information on external bodies which grant ethics approval.

You need to wait for ethical and/or governance approval before you start your research.

Section 4: Project Details

Management of Ethical Risk

For each of Questions 1-10 and Question 24, where you have responded 'Yes', please explain for the committee how you justify and will manage the ethical risk created. Your research is in the Yellow risk category.

1	Involve human participants?		YES

My research focuses on extreme movement, mainly those dancers are capable of executing. Dance choreography is a significant part of my work. I will work on myself initially as a participant and then professional dancers to see how they respond to the material interfaces I create. They must all above 18 years of age and ideally of professional standing. There will be no exclusion based on gender, ethnicity, beliefs, sexual orientation. They will be selected based on their technical ability, artistic expression, emotional maturity, ability to articulate their experiences and general interest in this project. All participants will be voluntarily consenting to take part in the project and the research will be done overtly.

4	Involve the co-operation of a 'gatekeeper' or institution to gain access to participants?		YES

I have already formed links with the English National Ballet and The Place, London. I may hold an audition at The Place to select dance artists. I may also post ads in UK dance industry locations like https://dancers.mandy.com/uk/jobs. I have also formed links with The Bartlett School of Architecture because of their location at Here East (alongside Studio Wayne McGregor) and research expertise around Design for Performance and Interaction. They also have research interests in Architecture & Digital Theory and 'From machine to body'. (https://www.ucl.ac.uk/bartlett/architecture/mphil-phd-architecture-and-digital-theory) These various institution may act as 'gatekeepers' depending on their level of involvement in my research. The Trinity Laban Conservatoire also has expertise in dance research, particularly in dance science. They may act as a sort of 'gatekeeper' if I want to use their dancers and/or facilities.

5	Offer financial or other forms of incentives to participants?		YES

As I intend to be using pre-professional or professional dancers they will need some form of compensation. I will require their rehearsal and performance time, which carry financial costs. It is imperative to have advanced-level dance artists with very strong ballet and contemporary training for my research.

8	Take place outside of the UK?		YES

I would like to attend International Association for Dance Medicine & Science conference. Whether this will be as a participant or junior presenter is still to be determined. I also work with a biostatistician who works with me independently but is based at Duke University Hospital in Durham, NC, USA. We will have two working sessions including interviews this summer: one in London and one in Switzerland. Aside from the above most of my research will take place in the UK, although there may be other conferences that arise elsewhere in the near future.

Section 5: Confirmation/Declaration Statements

	Confirmation Statements (delete as appropriate)	
1	I have completed the relevant training in research ethics.[3]	YES
2	I have consulted the Research Ethics Policy.	YES
3	I have completed a Risk Assessment (Health and Safety).[4]	YES
4	My research complies with the UK Data Protection Act (1998) and/or the data protection laws of the country where the research is being conducted.[5]	YES
5	For research funded externally where the funding was acquired via the RCA, I have completed a Project Risk Assessment.[6]	Not applicable
6	I have attached my confirmation of passing a Safeguarding course.	Not applicable
7	If my research project involves a contract between the RCA and an external party, I have had the contract approved by the RKE Office and the College's Chief Operating Officer[7]	Not applicable

Confirmation of Data Storage Compliance

By sending this form you confirm that:

- Physical documents containing personal or confidential information will be stored securely and only accessible to the research team and other authorised individuals.
- You will not store protected information [as defined by the Data Protection Act 1998] in personal cloud services, such as Dropbox, Google Drive or Microsoft OneDrive as their quality, accessibility and security cannot be guaranteed.
- Any portable media, such as USB storage devices, removable hard drives, CDs or DVDs, that are used to hold personal, confidential or sensitive data will be securely stored on-premises and appropriately encrypted when used off-premises.
- Access to RCA remote desktop facilities will always be via an approved RCA connection method such as VPN.

The preferred storage solution for electronic files is on an RCA server accessed from a password protected computer.
Please consult the College's IT Acceptable Use Policy and Regulations on the Use of IT for further information and guidance.

Applicant Declaration

By sending this form from my RCA e-mail account, I confirm that I will undertake the research as detailed here. I understand that I must abide by the terms of my ethical approval and that I may not amend the research without further ethical approval. I also confirm that the research will comply with all RCA ethical guidance, all relevant legislation and any relevant professional or funding body ethical guidance.

Supervisor/First Supervisor Declaration

By sending this form from my RCA e-mail account, I confirm the statements in the Applicant Declaration and that I will supervise the research as detailed in the application.

Thank you for completing the Stage 1 Research Ethics Application Form.

Please submit it as follows:

Staff Researchers: Send form to ethics@rca.ac.uk

Student Researchers: Send form to First Supervisor

Supervisor/First Supervisor: Check application and send to ethics@rca.ac.uk.

For REC details please see the RCA Research Ethics Policy.

[3] All researchers must submit confirmation with this form that they have undertaken ethics training. Some courses have exemption from this requirement. Please check with your supervisor/programme tutor.
[4] For research conducted at RCA, the College policies and guidelines must be followed. Researchers carrying out work at other institution/venues must also follow local processes. Where policies conflict, advice must be sought from the RCA Head of H&S.
[5] See the RCA Research Ethics Policy (Annex 1) for more information.
[6] The Health and Safety Risk Assessment form can be used as a template for the Project Risk Assessment, but should cover all risks, including health and safety. https://intranet.rca.ac.uk/risk-assessment/
[7] For details contact ethics@rca.ac.uk

Ethics Approval – 21 September 2018

From: **RCA Ethics** ethics@rca.ac.uk
Subject: Re: Epigeum Research Ethics Course
Date: September 21, 2018 at 1:46 PM
To: Nigel Garnett nigel.garnett@network.rca.ac.uk
Cc: Flora McLean flora.mclean@rca.ac.uk

ER

Dear Nigel,

Thank you for the additional information. This has now been reviewed and there is one small correction required. In your Participant Information Sheet please remove the reference to 'functional electrical stimulation'.

On the understanding that this amendment is made, your Ethics Application has been conditionally approved.

Good luck with your future research.

Kind regards,

Research Ethics Team.

On Sat, 15 Sep 2018 at 13:18, Nigel Garnett <nigel.garnett@network.rca.ac.uk> wrote:

> Dear Ethics Department,
>
> Thank you for your email.
>
> Please note I have removed FES (functional electrical stimulation) entirely from my research at this stage. I am opting for stimulation to come via other methods, notably very small vibrations, slight change in temperature or soft robotic contact. There will be no direct use of electrical or intense stimulation as this is not the intent of the process relative to my research. A very small signal is required so that the dancer wearing the device knows to use that part of the body to initiate their movement.
>
> With respect to recruitment this will be done mainly through dance artists I have either worked with in my past work. This is my first point of call. If any further recruitment is required this will be done in an open audition, likely at The Place https://www.theplace.org.uk/ where I have previously held an audition. The audition will probably be advertised via The Place and at https://dancers.mandy.com/uk, which is a common professional dancers platform. For the moment there are not institutions from which I will attempt to recruit dancers, however if these do become necessary I understand that I must obtain written permission from each organisation. They would all be institutions at university level or higher or professional entities. No dancers below the age of 18 will be involved.
>
> Please confirm if this is now sufficient for ethics approval.
>
> Many thanks for your help,
>
> Nigel
>
> **Nigel Guérin-Garnett, MA**
>
> MPhil/PhD Candidate
>
> School of Design Research
> Kensington Gore SW7 2EU London
> e: nigel.garnett@network.rca.ac.uk
> t: +44 (0)7851 875815
>
> On 15 August 2018 at 16:47, RCA Ethics <ethics@rca.ac.uk> wrote:
>
> > Dear Nigel,
> >
> > Thank you for the additional documentation. Following a review of these documents there are several issues that requires attention before approval can be forthcoming.

Updated Ethics Application – 10 February 2022

From: **Nigel Guérin-Garnett** nigel.garnett@network.rca.ac.uk
Subject: ethics approval questions post Spring '22 DTP
Date: February 10, 2022 at 1:11 PM
To: Ethics Rca ethics@rca.ac.uk

NG

Dear Ethics Team,

Following the ethics session during last week's Doctoral Training Programme I have some questions relative to my existing ethics approval. I have included the original form that was approved per the email chain below FYR.

After securing an artist's residency at Studio Wayne MacGregor I will finally be able to work with dancers as participants in a studio setting. The details of what is required of them is contained in the updated Participant Information & Consent Forms taken from the RCA intranet, also attached.

In my 2018 Research Ethics Application Form I ticked 'yes' in question 5. "*Offer financial or other forms of incentives to participants?*" as it would be unethical to ask my participants to practice, rehearse or perform without financial compensation. These participants are professional dance artists where these activities form part of how they earn a living. Considering the level required to effectively carry out this research it will not be logical to work with amateur dancers or students.

1. During the Zoom webinar last week this question was mentioned as being updated to 'strongly discourage' researchers to remunerate their participants. I would like to ensure there is no conflict between my approved ethics application and the activities I will soon be carrying out with my research participants. Can you please advise?

2. Within the email exchanges below I was explicit in mentioning how I would recruit my participant dancers, which included via my existing networks, professional dancer job sites (Mandy Dancers) and dance studios / job board (The Place). These remain true, however I am adding Studio Wayne McGregor as a further source as they have several existing professional dance networks for contemporary dancers. For clarity the residency does not involve any form of transaction, financial or otherwise, it was awarded to me via a competition I applied to in Summer 2021 and awards me free studio space and access to their networks as listed here. SWM is aware I am conducting research during this residency. Considering the similar nature of these additions, can you advise if my ethics approval stands as is?

Kindly advise on the above.

Many thanks,

Nigel

Sample_Survey_Inform...2.docx

Participant_Information...1.docx

Nigel Guérin-Garnett

PhD Researcher | Design Practitioner

School of Design Research
nigel.garnett@network.rca.ac.uk

Royal College of Art

> Begin forwarded message:
>
> **From:** Nigel Garnett <nigel.garnett@network.rca.ac.uk>
> **Subject:** **Re: Epigeum Research Ethics Course**
> **Date:** September 22, 2018 at 2:22:34 PM GMT+2
> **To:** RCA Ethics <ethics@rca.ac.uk>
> **Cc:** Flora McLean <flora.mclean@rca.ac.uk>
>
> Dear Ethics Department,

Updated Ethics Approval – 4 March 2022

From: **RCA Ethics** ethics@rca.ac.uk
Subject: Re: ethics approval questions post Spring '22 DTP
Date: March 4, 2022 at 12:37 PM
To: Nigel Guérin-Garnett nigel.garnett@network.rca.ac.uk

ER

Hi Nigel,

Thanks for your patience with this. Your query has been reviewed and I can confirm that you have the go ahead to progress with both points 1 and 2 based on the information supplied.

Best wishes,
Rosie

On Sat, 26 Feb 2022 at 12:50, Nigel Guérin-Garnett <nigel.garnett@network.rca.ac.uk> wrote:

> Hi Rosie,
>
> Thanks for your email.
>
> Understood that internal consultation is needed, however could you advise when this may be complete as it has been a couple weeks… I feel I should reiterate how important these upcoming practice is to this project. Testing the choreographic system with real dancers and eliciting feedback from an expert audience is central to understanding the relevancy and eventual applications of this knowledge generation. It is the main point of the PhD.
>
> No professional dancer (or indeed pre-professional or student in a university programme) should be asked to work for free, or non-monetary remuneration. And, as mentioned, it would be unethical if I tried to recruit participants of this nature without financial compensation for their participation and performance.
>
> Kindly advise at your earliest convenience as there are some interested participants who are at professional dance company level.
>
> Thank you for your help and best wishes,
>
> Nigel

Nigel Guérin-Garnett

PhD Researcher | Creative Practitioner

School of Design Research
nigel.garnett@network.rca.ac.uk

Royal College of Art

> On Feb 11, 2022, at 6:56 PM, RCA Ethics <ethics@rca.ac.uk> wrote:
>
> Hi Nigel,
>
> Thanks for your email. I will need to consult with the team on your questions below and will be back in touch when I have further guidance for you.
>
> Thanks for your patience.
>
> Best wishes,
> Rosie
>
> On Thu, 10 Feb 2022 at 12:11, Nigel Guérin-Garnett <nigel.garnett@network.rca.ac.uk> wrote:
>
> > Dear Ethics Team,
> >
> > Following the ethics session during last week's Doctoral Training Programme I have some questions relative to my existing ethics approval. I have included the original form that was approved per the email chain below FYR.

Royal College of Art
RESEARCH & INNOVATION

CONSENT TO PARTICIPATE IN RESEARCH

A Choreographic Materialisation of AI

Dear Participant,

You are invited to participate in a research study conducted by Nigel Guérin-Garnett (Researcher), from the School of Design at the Royal College of Art, as part of my PhD research. Your participation in this study is entirely voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether or not to participate.
You have been asked to participate in this study based on your capabilities as a dance artist. This choice was based on my judgement of your ability to carry out the activities.

- **PURPOSE OF THE STUDY**

This stage of the project is designed to study and document the effects of physical stimulation provided by wearable accessories on dancers within a choreographic context.

- **PARTICIPATION**

If you volunteer to participate in this study, you will be asked to do the following things:

Activities

- Participate in one-to-one interviews and group discussions as honestly as you can and to the best of your ability
- Complete surveys as honestly as you can and to the best of your ability
- Participate in workshops, rehearsals and demonstrations as scheduled and agreed with the Researcher
- Respond to the Researcher's questions and investigations in the truest way possible
- Take choreographic direction from the Researcher
- Try on and wear different wearable accessories embedded with varying forms of stimulation supplied by the Researcher that may include: vibrations, changes in temperature, soft robotic movement or variations of these techniques
- Try on the wearables pieces supplied by the Researcher made from different materials and provide feedback on their comfort, functionality, aesthetic and any other variables potentially beneficial in their development
- Have photographs, video and sound recordings taken of you

Research Office Royal College of Art Kensington Gore London SW7 2EU
t +44 (0)20 7590 4126 f +44 (0)20 7590 4542 research@rca.ac.uk www.rca.ac.uk/research

Duration & Location

- These sessions will take place in two separate blocks of time in the Spring of 2022. The first will be 2 days and the second will be 3 to 5 days. Exact dates will be agreed with you.
- The study will take place at:

Research Office Royal College of Art Kensington Gore London SW7 2EU
t +44 (0)20 7590 4126 f +44 (0)20 7590 4542 research@rca.ac.uk www.rca.ac.uk/research

Studio Wayne McGregor Broadcast Centre, Here East 10 East Bay Lane Queen Elizabeth Olympic Park London E15 2GW	AND	Royal College of Art Kensington Gore London SW7 2EU; 1 Hester Road, London SW11 4AN; Dorando Close, London W12 7FN

Remuneration

- It would be unethical to request for professional / artistic input without financial payment.
- Each participant will be paid pursuant to the parallel Agreement Letter provided.

· **POTENTIAL RISKS AND DISCOMFORTS**

The main source of physical stimulation used in this study will be vibration. The intensity should be approximately similar to a mobile phone vibrating. However, the wearable devices that contain the vibrating motors will be placed on various points of the body, for example the shoulders, back, neck, chest, legs, arms, abdominals. You may wish to test the sensation on your hand or arm before trying it elsewhere, for example. The vibration may provide some mild discomfort or feel unusual. But your permission will be sought in advance of testing the vibration anywhere on your body, and you may refuse any location at any time without being disadvantaged in any way.

In the event of physical and/or mental injury resulting from participation in this research project, the Royal College of Art does not provide any medical, hospitalisation or other insurance for participants in this research study, nor will the Royal College of Art provide any medical treatment or compensation for any injury sustained as a result of participation in this research study, except as required by law.

· **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

It is hoped that the outcomes of this research project will help inform an ethical and human-centred use of artificial intelligence within creative processes.
Your professional development may also benefit from the experimental methods of choreography being employed in these sessions.

· **CONFIDENTIALITY**

It is essential to capture as much useful information as possible during these sessions for the purposes of this research project. This is to review for analysis and to create edited imagery for research presentations. Digital video cameras, smartphone cameras and digital sound recorders will be used to record the interviews, discussions, workshops, rehearsals and demonstrations.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your personal and private data will be kept confidential via storage on the Researcher's personal Google Drive, hard-drive, iPhone, iPad and/or laptop during the research. After thesis publication, it will only be stored on the same Google Drive and hard drive for at least 7 years. Your data will not be stored on RCA-owned or public access devices or platforms, with the exception of the Royal College of Art research repository, only following thesis publication. Parts of the digital files may be shared with the Researcher's supervisory team and video/sound/photo editors. Any other disclosure of this information will not occur without your explicit permission.

· **PARTICIPATION AND WITHDRAWAL**

You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. You may also refuse to answer any questions you do not want to answer. There is no penalty if you withdraw from the study.

· **RIGHTS OF RESEARCH SUBJECTS**

The Royal College of Art Research Ethics Committee has reviewed my request to conduct this project. If you have any concerns about your rights in this study, please contact them at ethics@rca.ac.uk

PARTICIPANT CONSENT:

I *(please print) Jordan James Bridge* have read the information above and all queries have been answered to my satisfaction. I agree to voluntarily participate in this research and give my consent freely. I understand that I can withdraw my participation from the project up to the point of publication, without penalty, and do not have to give any reason for withdrawing.

I understand that all information gathered will be stored securely, and my opinions will be accurately represented. Any data in which I can be clearly identified will be used in the public domain only with my consent.

Participant Signature.....

Researcher Signature

Date: 06/03/22

Complaints Procedure:

This project follows the guidelines laid out by the Royal College of Art Research Ethics Policy.

If you have any questions, please speak with the researcher. If you have any concerns or a complaint about the manner in which this research is conducted, please contact the RCA Research Ethics Committee by emailing ethics@rca.ac.uk or by sending a letter addressed to:

The Research Ethics Committee
Royal College of Art
Kensington Gore
London
SW7 2EU

Royal College of Art
RESEARCH & INNOVATION

CONSENT TO PARTICIPATE IN RESEARCH

A Choreographic Materialisation of AI

Dear Participant,

You are invited to participate in a research study conducted by Nigel Guérin-Garnett (Researcher), from the School of Design at the Royal College of Art, as part of my PhD research. Your participation in this study is entirely voluntary. Please read the information below and ask questions about anything you do not understand, before deciding whether or not to participate.
You have been asked to participate in this study based on your capabilities as a dance artist. This choice was based on my judgement of your ability to carry out the activities.

- **PURPOSE OF THE STUDY**

This stage of the project is designed to study and document the effects of physical stimulation provided by wearable accessories on dancers within a choreographic context.

- **PARTICIPATION**

If you volunteer to participate in this study, you will be asked to do the following things:

Activities

- Participate in one-to-one interviews and group discussions as honestly as you can and to the best of your ability
- Complete surveys as honestly as you can and to the best of your ability
- Participate in workshops, rehearsals and demonstrations as scheduled and agreed with the Researcher
- Respond to the Researcher's questions and investigations in the truest way possible
- Take choreographic direction from the Researcher
- Try on and wear different wearable accessories embedded with varying forms of stimulation supplied by the Researcher that may include: vibrations, changes in temperature, soft robotic movement or variations of these techniques
- Try on the wearables pieces supplied by the Researcher made from different materials and provide feedback on their comfort, functionality, aesthetic and any other variables potentially beneficial in their development
- Have photographs, video and sound recordings taken of you

Duration & Location

- These sessions will take place in two separate blocks of time in the Spring of 2022. The first will be 2 days and the second will be 3 to 5 days. Exact dates will be agreed with you.
- The study will take place at:

Research Office Royal College of Art Kensington Gore London SW7 2EU
t +44 (0)20 7590 4126 f +44 (0)20 7590 4542 research@rca.ac.uk www.rca.ac.uk/research

Studio Wayne McGregor Broadcast Centre, Here East 10 East Bay Lane Queen Elizabeth Olympic Park London E15 2GW	AND	Royal College of Art Kensington Gore London SW7 2EU; 1 Hester Road, London SW11 4AN; Dorando Close, London W12 7FN

Remuneration

- It would be unethical to request for professional / artistic input without financial payment.
- Each participant will be paid pursuant to the parallel Agreement Letter provided.

· **POTENTIAL RISKS AND DISCOMFORTS**

The main source of physical stimulation used in this study will be vibration. The intensity should be approximately similar to a mobile phone vibrating. However, the wearable devices that contain the vibrating motors will be placed on various points of the body, for example the shoulders, back, neck, chest, legs, arms, abdominals. You may wish to test the sensation on your hand or arm before trying it elsewhere, for example. The vibration may provide some mild discomfort or feel unusual. But your permission will be sought in advance of testing the vibration anywhere on your body, and you may refuse any location at any time without being disadvantaged in any way.

In the event of physical and/or mental injury resulting from participation in this research project, the Royal College of Art does not provide any medical, hospitalisation or other insurance for participants in this research study, nor will the Royal College of Art provide any medical treatment or compensation for any injury sustained as a result of participation in this research study, except as required by law.

· **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

It is hoped that the outcomes of this research project will help inform an ethical and human-centred use of artificial intelligence within creative processes.
Your professional development may also benefit from the experimental methods of choreography being employed in these sessions.

· **CONFIDENTIALITY**

It is essential to capture as much useful information as possible during these sessions for the purposes of this research project. This is to review for analysis and to create edited imagery for research presentations. Digital video cameras, smartphone cameras and digital sound recorders will be used to record the interviews, discussions, workshops, rehearsals and demonstrations.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your personal and private data will be kept confidential via storage on the Researcher's personal Google Drive, hard-drive, iPhone, iPad and/or laptop during the research. After thesis publication, it will only be stored on the same Google Drive and hard drive for at least 7 years. Your data will not be stored on RCA-owned or public access devices or platforms, with the exception of the Royal College of Art research repository, only following thesis publication. Parts of the digital files may be shared with the Researcher's supervisory team and video/sound/photo editors. Any other disclosure of this information will not occur without your explicit permission.

· **PARTICIPATION AND WITHDRAWAL**

You can choose whether or not to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. You may also refuse to answer any questions you do not want to answer. There is no penalty if you withdraw from the study.

· **RIGHTS OF RESEARCH SUBJECTS**

The Royal College of Art Research Ethics Committee has reviewed my request to conduct this project. If you have any concerns about your rights in this study, please contact them at ethics@rca.ac.uk

PARTICIPANT CONSENT:

I *(please print) ...Eileih Muir*..... have read the information above and all queries have been answered to my satisfaction. I agree to voluntarily participate in this research and give my consent freely. I understand that I can withdraw my participation from the project up to the point of publication, without penalty, and do not have to give any reason for withdrawing.

I understand that all information gathered will be stored securely, and my opinions will be accurately represented. Any data in which I can be clearly identified will be used in the public domain only with my consent.

Participant Signature.....Eileih Muir.....

Researcher Signature 

Date: .....2.05.2022.....

Complaints Procedure:

This project follows the guidelines laid out by the Royal College of Art Research Ethics Policy.

If you have any questions, please speak with the researcher. If you have any concerns or a complaint about the manner in which this research is conducted, please contact the RCA Research Ethics Committee by emailing ethics@rca.ac.uk or by sending a letter addressed to:

The Research Ethics Committee
Royal College of Art
Kensington Gore
London
SW7 2EU

AGREEMENT LETTER

Nigel Guérin-Garnett
Research Office, School of Design
Royal College of Art
Kensington Gore SW7 2EU London
nigel.garnett@network.rca.ac.uk

Jordan James Bridge
4E Mitre Road
London SE1 8PY
jordanjamesbridge@gmail.com

5 April 2022

MACHINATIA* | *A Choreographic Materialisation of AI

Dear Jordan,

By signing and returning a copy of this letter, you will enter into a legal agreement between us in which you agree to perform in research sessions and a demonstration, which are part of academic research for a future publication.

1. Time, place and duration of research and demonstration

You will perform 5 research days at Studio Wayne McGregor, Broadcast Centre, Here East, 10 East Bay Lane, Queen Elizabeth Olympic Park, London E15 2GW or any of the Royal College of Art campuses located at:
South Kensington - Kensington Gore SW7 2EU London;
Battersea - 1 Hester Road, London SW11 4AN;
White City - Dorando Close, London W12 7FN;

And perform 1 demonstration at Studio Wayne McGregor, at the same above address.

The rehearsal days will take place on 13 and 14 April ("Session 1"), and 8, 9, 10 June, 2022 ("Session 2"). The demonstration will take place on 10 or 11 June, with the final timing to be agreed at least one month in advance. Including warm-up, preparation, the performance and audience feedback the demonstration will be 3 ½ hours or less.

2. Fees

2.1. I shall pay you a fee of £850.00 for 5 ½ days of research/demonstration including VAT.

2.2. I shall pay £400 of the fee within 15 days upon the presentation of your invoice for Session 1; and the remaining £450 of the fee within 15 days upon presentation of your invoice for Session 2. These two payments will be paid via BACS transfer and will constitute complete payment for your services rendered within this agreement.

3. Travel, subsistence and accommodation

You will be responsible for arranging any travel, food and drink and accommodation necessitated by the research sessions and demonstration and will bear all the expenses of these. However, local London travel expenses to and from any of the Royal College of Art campuses will be reimbursed upon the presentation of receipts.

4. Your conduct

You agree that you will not do anything, while on the premises where the performance is to take place, that is illegal or otherwise likely to cause complaint from the premises owner, operator or guests, including for example taking illegal drugs or deliberately injuring or threatening any person.

5. Venue and equipment

5.1. I confirm that my agreement with the venue owner or tenant contains all provisions reasonably necessary to ensure your comfort and safety on the premises and we agree that if you have any concerns about safety or access issues, we shall promptly notify these to the venue operator.

5.2. You indemnify me for any damage caused by you to the venue or the equipment provided for your performance. I shall be responsible for any damage caused to your equipment while it is at the venue that is not caused directly by you, and we shall maintain sufficient insurance to cover such liabilities.

6. Publicity, promotion and confidentiality

6.1. I may promote your performance through approved research networks, targeted guest lists and social media, where appropriate. You may also promote through your own social media channels with my approval of the material.

6.2. After publication you do not require my permission to use any material provided or requested by you for your own promotion. However, you must credit me when disseminating any material, and vice versa.

6.3. You shall provide me with and allow me to use and reproduce your name, approved likeness and approved biographical material in connection with promoting your performance. All material supplied to me by you or your agent shall be deemed to be approved for these purposes unless you have informed me to the contrary in writing in advance.

6.4. I agree not to include in any promotional material for the performance anything reasonably likely to damage your business interests or reputation, and vice versa.

6.5. The material generated during the research sessions and demonstration will be considered intellectual property for a future publication. Except for the material agreed in 6.1, you agree not to disclose any other information via any means until after publication, whose date will be communicated to you once known in writing to your email address.

7. Rights of cancellation and rescheduling

7.1. If necessary, I will seek to reschedule Session 1, Session 2 and/or the demonstration to times that are suitable for both parties in the first instance. If this is not possible, I have the right to cancel or reschedule these events with at least 15 days written notice to you (which may be by email to jordanjamesbridge@gmail.com and will be deemed received when sent).

7.2. If I cancel any research session or performance under this provision, you will be entitled to keep all fees in relation to that session or performance that have already fallen due on the date when you receive our notice of cancellation.

7.3. If you cancel any research session or performance less than 15 days in advance or fail to deliver performance other than for a reason set out in paragraph 11, you shall refund to us within ten working days of the intended performance date all fees already paid to you for that session or demonstration.

8. Force majeure

If you are prevented from giving a performance by events, circumstances or causes beyond your reasonable control such as flood, epidemic, terrorist attack, fire or failure of a utility service, you will not be liable to return any of the fees for that performance, provided that you use all reasonable endeavours to mitigate the effect of the event, circumstance or cause.

9. Dispute resolution

If any dispute arises in connection with this agreement, you and I agree to enter into discussions in good faith to settle it.

10. Entire agreement

This agreement constitutes the entire agreement between us.

11. Governing law

This agreement and any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with it or its subject matter or formation shall be governed by and construed in accordance with the law of England and Wales.

12. Jurisdiction

You and I irrevocably agree that the courts of England and Wales shall have exclusive jurisdiction to settle any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with this agreement or its subject matter or formation.

Yours sincerely,

Nigel Guérin-Garnett

I hereby acknowledge receipt and accept the contents of this letter

Signed: 

Jordan James Bridge

Date: 06/03/22

AGREEMENT LETTER

Nigel Guérin-Garnett
Research Office, School of Design
Royal College of Art
Kensington Gore SW7 2EU London
nigel.garnett@network.rca.ac.uk

Eileih Muir
Flat 3, 49A Leigham Court Road
Streatham Hill
London SW16 2NF
eileihmuir@yahoo.co.uk

5 April 2022

MACHINATIA | A Choreographic Materialisation of AI

Dear Eileih,

By signing and returning a copy of this letter, you will enter into a legal agreement between us in which you agree to perform in research sessions and a demonstration, which are part of academic research for a future publication.

1. Time, place and duration of research and demonstration

You will perform 3 research days at Studio Wayne McGregor, Broadcast Centre, Here East, 10 East Bay Lane, Queen Elizabeth Olympic Park, London E15 2GW or any of the Royal College of Art campuses located at:
South Kensington - Kensington Gore SW7 2EU London;
Battersea - 1 Hester Road, London SW11 4AN;
White City - Dorando Close, London W12 7FN;

And perform 1 demonstration at Studio Wayne McGregor, at the same above address.

The rehearsal days will take place on and 8, 9, 10 June, 2022 ("Session 2"). The demonstration will take place on 10 or 11 June, with the final timing to be agreed at least one month in advance. Including warm-up, preparation, the performance and audience feedback the demonstration will be 3 ½ hours or less.

2. Fees

2.1. I shall pay you a fee of £550.00 for 3 ½ days of research/demonstration including VAT.

2.2. I shall pay the £550 fee within 15 days upon the presentation of your invoice for Session 2. This payment will be paid via BACS transfer and will constitute complete payment for your services rendered within this agreement.

3. Travel, subsistence and accommodation

You will be responsible for arranging any travel, food and drink and accommodation necessitated by the research sessions and demonstration and will bear all the expenses of these. However, local London travel expenses to and from any of the Royal College of Art campuses will be reimbursed upon the presentation of receipts.

4. Your conduct

You agree that you will not do anything, while on the premises where the performance is to take place, that is illegal or otherwise likely to cause complaint from the premises owner, operator or guests, including for example taking illegal drugs or deliberately injuring or threatening any person.

5. Venue and equipment

5.1. I confirm that my agreement with the venue owner or tenant contains all provisions reasonably necessary to ensure your comfort and safety on the premises and we agree that if you have any concerns about safety or access issues, we shall promptly notify these to the venue operator.

5.2. You indemnify me for any damage caused by you to the venue or the equipment provided for your performance. I shall be responsible for any damage caused to your equipment while it is at the venue that is not caused directly by you, and we shall maintain sufficient insurance to cover such liabilities.

6. Publicity, promotion and confidentiality

6.1. I may promote your performance through approved research networks, targeted guest lists and social media, where appropriate. You may also promote through your own social media channels with my approval of the material.

6.2. After publication you do not require my permission to use any material provided or requested by you for your own promotion. However, you must credit me when disseminating any material, and vice versa.

6.3. You shall provide me with and allow me to use and reproduce your name, approved likeness and approved biographical material in connection with promoting your performance. All material supplied to me by you or your agent shall be deemed to be approved for these purposes unless you have informed me to the contrary in writing in advance.

6.4. I agree not to include in any promotional material for the performance anything reasonably likely to damage your business interests or reputation, and vice versa.

6.5. The material generated during the research sessions and demonstration will be considered intellectual property for a future publication. Except for the material agreed in 6.1, you agree not to disclose any other information via any means until after publication, whose date will be communicated to you once known in writing to your email address.

7. Rights of cancellation and rescheduling

7.1. If necessary, I will seek to reschedule Session 1, Session 2 and/or the demonstration to times that are suitable for both parties in the first instance. If this is not possible, I have the right to cancel or reschedule these events with at least 15 days written notice to you (which may be by email to jordanjamesbridge@gmail.com and will be deemed received when sent).

7.2. If I cancel any research session or performance under this provision, you will be entitled to keep all fees in relation to that session or performance that have already fallen due on the date when you receive our notice of cancellation.

7.3. If you cancel any research session or performance less than 15 days in advance or fail to deliver performance other than for a reason set out in paragraph 11, you shall refund to us within ten working days of the intended performance date all fees already paid to you for that session or demonstration.

8. Force majeure

If you are prevented from giving a performance by events, circumstances or causes beyond your reasonable control such as flood, epidemic, terrorist attack, fire or failure of a utility service, you will not be liable to return any of the fees for that performance, provided that you use all reasonable endeavours to mitigate the effect of the event, circumstance or cause.

9. Dispute resolution

If any dispute arises in connection with this agreement, you and I agree to enter into discussions in good faith to settle it.

10. Entire agreement

This agreement constitutes the entire agreement between us.

11. Governing law

This agreement and any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with it or its subject matter or formation shall be governed by and construed in accordance with the law of England and Wales.

12. Jurisdiction

You and I irrevocably agree that the courts of England and Wales shall have exclusive jurisdiction to settle any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with this agreement or its subject matter or formation.

Yours sincerely,

Nigel Guérin-Garnett

I hereby acknowledge receipt and accept the contents of this letter

Signed ……Eileih Muir ……

Eileih Muir

Date ……02.05.2022……

AGREEMENT LETTER

Nigel Guérin-Garnett
Research Office, School of Design
Royal College of Art
Kensington Gore SW7 2EU London
nigel.garnett@network.rca.ac.uk

Gregor Petrikovic
Via email to:
gregor.petrikovic@network.rca.ac.uk
London

12 April 2022

MACHINATIA | A Choreographic Materialisation of AI

Dear Gregor,

By signing and returning a copy of this letter, you will enter into a legal agreement between us in which you agree to video and photograph research sessions and a demonstration, which are part of academic research for a future publication.

1. Time, place and duration of research

You will record/document 1 research day on 14 April at Studio Wayne McGregor, Broadcast Centre, Here East, 10 East Bay Lane, Queen Elizabeth Olympic Park, London E15 2GW.

2. Deliverables

2.1 You are to delivery videography and photography outputs from1 day of shooting, to include at least:

2.2 1 video clip up to 2 minutes in length that cohesively represents the research work being carried out. This illustration is aimed at an audience uninitiated to the subject matter.

2.3 A shorter video clip taken from the footage in 2.2 no longer than 1 minute in length for an academic audience that may have some prior knowledge of the subject. This will be submitted alongside a separate written chapter, abstract, photographs/images and a contextual presentation of the research, not supplied by you.

2.4. 1 to 2 video clips and still images for social media, such as Instagram.

3. Fees

3.1 I shall pay you a fee of £250.00 including VAT for the 1 research day and necessary editing time to satisfactorily complete the deliveries listed above in section 2.

3.2 I shall pay this fee within 15 days upon the presentation of your invoice. This payment will be paid via BACS transfer and will constitute complete payment for your services rendered within this agreement.

4. Travel, subsistence and accommodation

You will be responsible for arranging any travel, food and drink and accommodation necessitated by the research sessions and demonstration and will bear all the expenses of these. However, local London travel expenses to and from any of the Royal College of Art campuses will be reimbursed upon the presentation of receipts.

5. Your conduct

You agree that you will not do anything, while on the premises where the recording is to take place, that is illegal or otherwise likely to cause complaint from the premises owner, operator or guests, including for example taking illegal drugs or deliberately injuring or threatening any person.

6. Venue and equipment

6.1 I confirm that my agreement with the venue owner or tenant contains all provisions reasonably necessary to ensure your comfort and safety on the premises and we agree that if you have any concerns about safety or access issues, we shall promptly notify these to the venue operator.

6.2 You indemnify me for any damage caused by you to the venue or the equipment provided for your videography services. I shall be responsible for any damage caused to your equipment while it is at the venue that is not caused directly by you, and we shall maintain sufficient insurance to cover such liabilities.

7. Publicity, promotion and confidentiality

7.1 I may promote your recordings through approved research networks, targeted guest lists and social media, where appropriate. You may also promote through your own social media channels with my approval of the material.

7.2 After publication you do not require my permission to use any material provided or requested by you for your own promotion. However, you must credit me when disseminating any material, and vice versa.

7.3 You shall provide me with and allow me to use and reproduce your name, approved likeness and approved biographical material in connection with promoting your recordings. All material supplied to me by you or your agent shall be deemed to be approved for these purposes unless you have informed me to the contrary in writing in advance.

7.4 I agree not to include in any promotional material for the performance anything reasonably likely to damage your business interests or reputation, and vice versa.

7.5 The material generated during the research sessions and demonstration will be considered intellectual property for a future publication. Except for the material agreed in 7.1, you agree not to disclose any other information via any means until after publication, whose date will be communicated to you once known in writing to your email address.

8. Rights of cancellation and rescheduling

8.1 If necessary, I will seek to reschedule the research times that are suitable for both parties in the first instance. If this is not possible, I have the right to cancel or reschedule these events with at least 15 days written notice to you (which may be by email to gregor.petrikovic@network.rca.ac.uk and will be deemed received when sent).

8.2 If I cancel any research session under this provision, you will be entitled to keep all fees in relation to that session or performance that have already fallen due on the date when you receive our notice of cancellation.

8.3 If you cancel any research session or performance less than 15 days in advance or fail to deliver recordings other than for a reason set out in paragraph 9, you shall refund to us within ten working days of the intended research date all fees already paid to you for that session.

9. Force majeure

If you are prevented from providing recording services by events, circumstances or causes beyond your reasonable control such as flood, epidemic, terrorist attack, fire or failure of a utility service, you will not be liable to return any of the fees for that recording, provided

that you use all reasonable endeavours to mitigate the effect of the event, circumstance or cause.

10. Dispute resolution

If any dispute arises in connection with this agreement, you and I agree to enter into discussions in good faith to settle it.

11. Entire agreement

This agreement constitutes the entire agreement between us.

12. Governing law

This agreement and any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with it or its subject matter or formation shall be governed by and construed in accordance with the law of England and Wales.

13. Jurisdiction

You and I irrevocably agree that the courts of England and Wales shall have exclusive jurisdiction to settle any dispute or claim (including non-contractual disputes or claims) arising out of or in connection with this agreement or its subject matter or formation.

Yours sincerely,

Nigel Guérin-Garnett

I hereby acknowledge receipt and accept the contents of this letter

Signed .....Gregor Petrikovic.....

Gregor Petrikovic

Date .....13/4/2022.....

Table 1. Continued.

Types of interactions			Period and authors (date of publication or of experiment)		
			Early stages	Late twentieth century	Early twenty-first century
					and Bisig (2016); Crnkovic-Friis and Crnkovic-Friis (2016); Du et al. (2017); McGregor (2017)
	1.3 Complement or substitute for the choreographer	1.3.1 Complement the choreographer's work with dance segments generated by the computer and integrated into a single choreography (may include computer-designed imagery and virtual dancers)			Lapointe and Époque (2005); Downie (2005); Gwee (2012)
		1.3.2 Substitute for the choreographer using generative algorithms and artificial intelligence to produce machine-designed dances without, or with very limited, human intervention			Gough (2005); Donahue et al. (2017)

(*continued*)

Table 1. Fifty years of interactions between information technologies and choreography.

Types of interactions			Period and authors (date of publication or of experiment)		
			Early stages	Late twentieth century	Early twenty-first century
1. Use of computers and information technology in the process of creating and performing choreography	1.1 Record, preserve, recall, analyze and teach dances and choreography	1.1.1 Use, adapt, or create dance notation systems to represent graphically and visually and to preserve choreographic designs	Noll (1967); Cunningham, as reported by Noll (1994, 2016)	Calvert (1986); Gray (1988); Venable (1989); Brightman (1990)	Wilke et al. (2005); Ebenreuter (2008); de Boer (2017)
		1.1.2 Use video recording and motion sensors to preserve and analyze dance movements with the help of computers		Simon Frazer University, University of Iowa, University of Waterloo, University of Pennsylvania, as reported in Politis (1987)	Zillner et al. (2002); Brick and Boker (2011); Salazar Sutil (2012); Aristidou et al. (2015); Jadhav et al. (2015); Crnkovic and Crnkovic (2016); de Boer (2017)
		1.2.3 Teach and train dancers, choreographers, and robots, using computerized dance recordings, visual displays, and algorithms		Politis (1987)	Gwee (2012); Jadhav et al. (2015); Abe et al. (2017); McGregor and deLahunta (2008)
	1.2 Assist and enhance the choreographic design process indirectly offstage: use computer programming languages, genetic algorithms, and artificial programs to explore options and decide on movements to design choreography in advance of performance		Pierce (1965); Beaman (1965); Noll (1967); Hutchinson, reported in Reichardt (1968); Moles (1968); Sagasti and Page (1970)	Herbison-Evans and Politis (1988); Landsown (1978, 1996); Ungvary et al. (1992); Bradford and Côté-Laurence (1995); De Sola, as reported by Katz (1998); Mebius (1998); Ventura and Bisig (2016)	Zillner et al. (2002); Klein et al. (2002); Hsieh and Luciani (2005); Lapointe (2005); Downie (2005); deLahunta (2008); Forsythe (2009); Carlson *et at* (2011); Gwee (2013); Jadhav et al. (2015); Ventura

(*continued*)

Table 1. Continued.

Types of interactions		Period and authors (date of publication or of experiment)		
		Early stages	Late twentieth century	Early twenty-first century
2. Use IT to design and control lighting, sound, or mechanical devices interacting with performing dancers	2.1 Directly onstage: Use video or sensors on dancers' bodies to capture, process, and project real-time movement onstage, either directly or as mediated by a human dance jockey who gives onstage instructions to the performers, TV camera operators, musicians, etc., by modulating computer-generated dance movements in real time.		Cordeiro (1977); Stopiello and Coniglio (2002)	Cordeiro (2007); Schiphorst (2007); Sicchio (2014); Isbister et al. (2016)
	2.2 Indirectly, offstage: in advance, design lighting, sound, and virtual dancers to accompany, complement, enhance, and interact with performing dancers			Choreographic Coding Labs (2009); Mondot and Bardienne (2017); McGregor (2017)
3. Use computer, physical, and biological sciences as metaphors to create choreography, and use choreography as a stimulus for philosophical speculation	3.1 Use scientific concepts to inspire choreographic designs			Streb, Armitage, Miller, and Rothlein as reported in Morgenroth (2010); Salazar Sutil (2012); Ventura and Bisig (2016)
	3.2 Use the interaction between IT and choreography as an entry point for examining consciousness and ephemerality			Bleeker (2017); Noë (2017)
4. Use information technology–mediated, real-time audience participation in the creation and performance of choreographies and dances				Bleeker (2017)

Prepared by the author. Please note that some of the sources are placed in more than one cell, especially during the early twenty-first-century period, because they illustrate more than one type of interaction between computers and choreography. References can be found in the endnotes.

Appendix IX: Computer-aided Choreographic Systems

Computer Aided Choreographic Systems:	Stage of Choreographic Process	Movement Generation (stage1)	Sequence Generation (stage 2, ~3)	Final Selection Method	Representation of Choreographic Data	Precision of Movement Description
DanceForms (LifeForms)	Movement, Sequence, Choreography	User or Library	User	User	Multiple Figures, Space and Orientation in 3D	High
Tour Jete, Pirouette	Sequence	User or Library	Swarm Technique	User	Multiple Figures, Space and Orientation in 3D	High
Web3D Composer	Sequence	Library	Interactive Possibilities	User	Single Figure, Space in 3D	High
Dancing Genome	Sequence	User/ Motion Capture	Genetic Algorithm	Fitness Function	Single Figure, Orientation in 3D	Medium
Dancing	Sequence, Choreography	Library	Genetic Algorithm and Music	Fitness Function	Two Figures, Space, Orientation in ASCII	Medium
Dance Evolution	Movement/ Animation of	Neural Net and Music	In Order of Creation	User	Multiple Figures, Orientation in 3D	Medium
Scuddle	Movement	Genetic Algorithm	In Order of Creation	Fitness Function	Single Figure in 2D	Low
Pre-1990 Systems	Movement	User or System	N/A	User	Shapes, Silhouettes, Minimal	Low

Table 1. Comparison of Related Computer-Aided Choreographic Systems

Comparative chart of computer-aided choreographic systems since 1990 (Carlson et al. 2011, pp.124).

Appendix X: Thematic Analysis Coding Examples

Table 3. Examples of different types of coding

Types of codes	Example	Extracted code	Principles of coding according to Polit & Beck (2010)[40]
Conceptual code	I knew only what the name of the drug was and which diseases it would treat, but I knew nothing about how it should be administered in practice.	Lack of knowledge on drugs' practical administration	In line with the reductionist nature of qualitative data management, the researcher converts large masses of data into smaller, more manageable segments as codes; Coding leads to breaking down data into incidents and examining their similarities and differences; The coding process is a cyclic process without a finite interpretation and the researcher's efforts determine the level of coding abstraction; Investigator triangulation as independent coding and analysis of some of the data by two or more researchers is an appropriate method for enhancing quality of the coding process.
Relationship code	Instructor's presence with students in clinical placement is necessary to make the collaboration of students in medication administration in clinical practice possible.	Necessity of instructor's supervision in medication education	
Participant perspective code	I believe that patients are fully able to check the accuracy of the nurse's medication administration.	Positive attitude towards patient's participation	
Participant characteristic code	As a final year and senior nursing student, I liked helping the nurse to administer drugs, but she did not allow me to work with her.	Senior student's eagerness to collaborate	
Setting code	In critical care settings, I have been provided with more chances to practice medication administration.	Critical care settings' cooperation in medication education	

(Vaismoradi et al. 2016, pg.104)

Appendix XI: Garment Sketches

Appendix XII: Arduino Code

Sending code from the fixed base

```
//UDP Client Code

#include <WiFi.h>
#include <WiFiUdp.h>

WiFiUDP Udp;  // Creation of wifi Udp instance

char packetBuffer[255];

unsigned int localPort = 9999;

const char *ssid = "BB9ESERVER";
const char *password = "BB9ESERVER";

boolean button_Pressed = false;

IPAddress ipServidor(192, 168, 4, 1);   // Declaration of default IP for server
/*
   The ip address of the client has to be different to the server
   other wise it will conflict because the client tries to connect
   to it self.
*/
IPAddress ipCliente(192, 168, 4, 10);   // Different IP than server
IPAddress Subnet(255, 255, 255, 0);
//
const int buttonPin = 4;
int buttonState  = LOW;

void setup() {
  Serial.begin(115200);
  WiFi.begin(ssid, password);
  WiFi.mode(WIFI_STA); // ESP-32 as client
  WiFi.config(ipCliente, ipServidor, Subnet);
  Udp.begin(localPort);
  pinMode(buttonPin, INPUT);
}

void loop() {
  //unsigned long Tiempo_Envio = millis();

  //SENDING
  Udp.beginPacket(ipServidor, 9999);  //Initiate transmission of data
  buttonState = digitalRead(buttonPin);

  if (buttonState == HIGH && button_Pressed == false) {
     Udp.printf("a");
     button_Pressed = true;
  } else if (buttonState == LOW && button_Pressed == true){
    Udp.printf("b");
    button_Pressed = false;
  }

  /*
    char buf[20];   // buffer to hold the string to append
```

```
    // unsigned long testID = millis();   // time since ESP-32 is running millis()
    int Data = 1;

    sprintf(buf, "%lu", Data);  // appending the millis to create a char
    Udp.printf(buf);  // print the char
   */
  Udp.printf("\r\n");   // End segment
  Udp.endPacket();  // Close communication


  delay(5); //

  //RECEPTION
  int packetSize = Udp.parsePacket();   // Size of packet to receive
  if (packetSize) {       // If we received a package

    int len = Udp.read(packetBuffer, 255);

    if (len > 0) packetBuffer[len - 1] = 0;
    Serial.print("RECIBIDO(IP/Port/Size/Datos): ");
    Serial.print(Udp.remoteIP()); Serial.print(" / ");
    Serial.print(Udp.remotePort()); Serial.print(" / ");
    Serial.print(packetSize); Serial.print(" / ");
    Serial.println(packetBuffer);
  }
  Serial.println("");
  delay(5);
}
```

Receiving code for the wearable apparatus

```
// UDP Access Point
// Tutorial - https://www.alejandrowurts.com/projects/esp32-wifi-udp/

#include <WiFi.h>
#include <WiFiUdp.h>

WiFiUDP Udp; // Creation of wifi Udp instance

char packetBuffer[255];
const int ledPin = 2;
char recived_data = 'x';

unsigned int localPort = 9999;

const char *ssid = "BB9ESERVER";
const char *password = "BB9ESERVER";

boolean button_Pressed = false;
boolean buzz = false;

void setup() {
  pinMode(ledPin, OUTPUT);
  Serial.begin(115200);
  WiFi.softAP(ssid, password);  // ESP-32 as access point
  Udp.begin(localPort);
}
```

```
void loop() {

  int packetSize = Udp.parsePacket();
  if (packetSize) {
    int len = Udp.read(packetBuffer, 255);
    if (len > 0) packetBuffer[len - 1] = 0;

    Serial.println(packetBuffer);
   // recived_data = packetBuffer[0];

    Udp.beginPacket(Udp.remoteIP(), Udp.remotePort());
    Udp.printf("received: ");
    Udp.printf(packetBuffer);
    Udp.printf("\r\n");
    Udp.endPacket();
  }
  if (packetBuffer[0] == 'a' ) {
    buzz = true;
  } else if (packetBuffer[0] == 'b' ){
    buzz = false;
  }
  if (buzz == true ) {
    digitalWrite(ledPin, HIGH);
    Serial.println("ON");
  } else if (buzz == false){
    digitalWrite(ledPin, LOW);
  }
}
```